G203
E573
N55

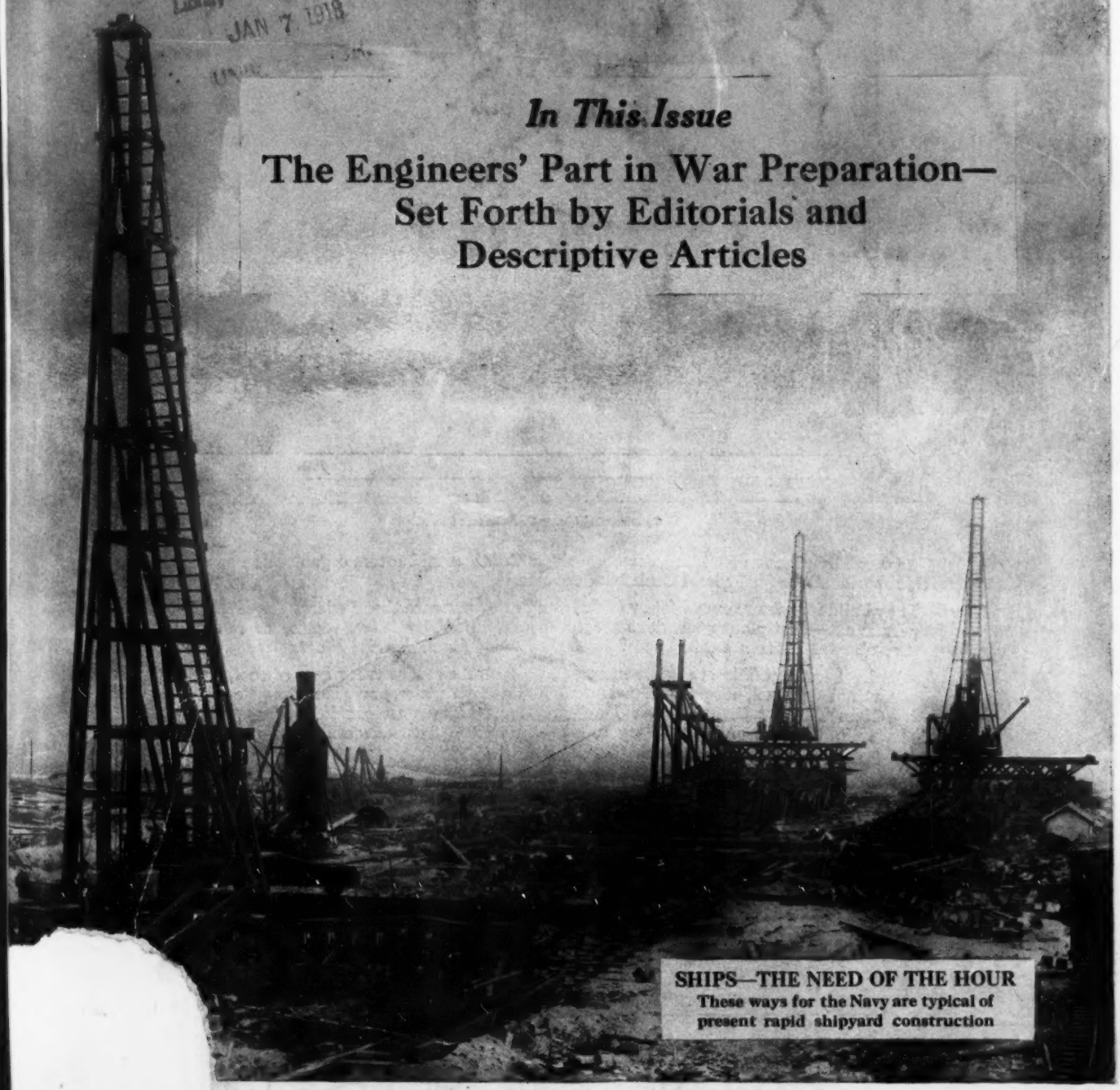
Engineering News-Record

A Consolidation of Engineering News and Engineering Record
McGRAW-HILL PUBLISHING COMPANY, Inc.
January 3, 1918

Engineering Library
JAN 7 1918

In This Issue

The Engineers' Part in War Preparation—Set Forth by Editorials and Descriptive Articles



SHIPS—THE NEED OF THE HOUR
These ways for the Navy are typical of present rapid shipyard construction

Build for Permanence

Continental Motor Co.'s Latest Plant.

The carefully planned Building Program of the Continental Motors organization again carried specifications for Federal Cement Tile Roofs.

They build for permanence. They *know* from past experience that Federal Cement Tile is permanent—that plant operations are never interrupted by leaks, repairs or renewals. Continental Motors *knows* it is *The Logical Roof for Industrial Plants.*

Federal Cement Tile are made in many styles and sizes for every type of roof, both flat and pitched, single thickness and hollow, with air space, including Federal Glass Tile for the "Famous Daylight Roof." Light weight interchangeable units that are quick and easy to lay—light enough to effect a considerable saving in supporting steel.

Federal Tile is the Logical Roof for your plant. Proof against all deteriorating forces—it is "*The Indestructible Roof.*" Do you want our booklet?

Federal Tile are Made, Laid and Guaranteed by

Federal Cement Tile Co.

920 Westminster Bldg., Chicago

"The Indestructible Roof"

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, *President*

ENGINEERING NEWS-RECORD

E. J. MEHREN, *Editor* CHARLES WHITING BAKER, *Consulting Editor*

M. N. BAKER
H. D. HAMMOND
F. E. SCHMITT
MONT SCHUYLER
C. W. STARK
FRANK C. WIGHT

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. E. R. TRATMAN, W. W. DEBERARD } *Chicago*
N. A. BOWERS, *San Francisco*
R. K. TOMLIN, JR., *Paris War Correspondent*

Volume 80 — NEW YORK, THURSDAY, JANUARY 3, 1918 — Number 1

Engineering News-Record is a consolidation of Engineering News and Engineering Record.

Engineering News was founded in 1874 by George H. Frost, as the "Engineer and Surveyor," which title subsequently became the "Engineer, Architect and Surveyor," then "Engineering News and American Railway Journal" and, finally, "Engineering News," under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as the "Plumber and Sanitary Engineer." The name was subsequently changed to the "Sanitary Engineer," "Engineering and Building Record" and, finally, to "Engineering Record." During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The War

WHAT of the war? What shall we say of this greatest of conflicts and of our part therein at this beginning of 1918?

We are airing our inefficiencies before Congress. We find delay in various departments, inefficiency in many directions. There is reason for believing that profiteering has not stopped. In fact, we have the word of the President, so recently as his Buffalo labor speech, that profiteering continues.

Moreover, the news from Washington does not tell the full story of our troubles. It does not disclose the serious industrial situation, the labor ferment, more or less quiescent since the American Federation of Labor met at Buffalo, but ready to burst forth at any minute and precipitate the most serious industrial disturbance we have ever known.

On the other side of the water, where the issue of blood is actually joined, the picture is quite as dark. Within the year Russia has been lost to the Entente cause, and Italy has had a serious setback.

The situation, looked at from these angles, is very black. But there are relieving aspects; there are reasons for optimism.

On the battle lines there is comfort in the ever-increasing strength of the Entente Allies on the Western front, where as the world knows, will rest the decision of the war. Again, Germany is slowly, but surely, crumbling. Internal dissensions are rife. There is a serious shortage of man power and material. Russia will not be of much help, for even the best of German organizing ability cannot pull order out of that hotbed of anarchy and revolution. While Russia is lost to the Allied cause, the gain to Germany is decidedly questionable.

As to the labor problem, there is discussion elsewhere in these columns. One thought is in order here: Was the taking over of the railroads by the President prompted chiefly by the hope of securing greater transportation efficiency, or by the probability of an easier handling of the labor situation? Interesting as that question is, it has not been and is not likely to be answered. Those who have faith in the ability of the railroad officials of the country to operate their properties efficiently will incline to the belief that the taking of the roads was largely due to the impending labor difficulty. Insofar as the labor problem may be more effectively handled under Government control, the railroad solution proposed by the President may help materially in a solution of the general problem of industrial unrest.

Coming now to the situation in Washington, we must admit freely not only the inefficiencies which obtain there, but also the value attached to airing them in the congressional hearings. Nevertheless, we should not forget the good things done at the capital since the beginning of the war. A reading of the article in this issue on the work of the General Engineer Depot indicates to some extent the problems that lay before the various executive departments and the committees of the Council of National Defense. The story of the cantonments has been well told in these pages, the increased efficiency in freight transportation is well known, while the daily press has commented upon the achievement of the Liberty Motor. Despite the shipbuilding controversies we *are* building ships, and after the stress and strife matters appear now to be shaping themselves so that the big program will surely be put through. In general, we are displaying in our attack on the war-organization problems at Washington the same freedom, the same originality, the same drive that has characterized the development of American industrial enterprises.

We are certain to show the same characteristics in our organization work in France. Our plans for unloading ships in France provide roughly for three and a half times the speed of unloading which is customary at the British ports, while our operating plans for the terminals and railroad lines insure a much greater effectiveness than is found on the English and French lines.

The French have done remarkably well with their macadam road system. Nevertheless, the maintenance price in man power has been enormous, while even

today the stone for those roads is crushed by hand. Such time-honored methods will be thrown into the discard when our forces in France are organized, and types of road may be expected which will require relatively little man power to maintain them for the heavy traffic they must carry.

Bearing in mind these comparisons and recalling that despite their methods of operation the French and the English have been able to hold the Germans in check for three years, nay, have forced them back, what can we not expect when the full force of America's resources in men, brains and material are brought into the conflict?

We may stumble and we may halt, but the end result is not in doubt. Our organizing genius, our ability to find new solutions for old problems, our free and original method of attacking any difficulty are recognized the world over—even in Germany, with its much vaunted scientific ability and efficiency. We may waste on the details, but *in the large we get results.* Our power has never been successfully challenged when initiative and the ability to develop new machines and get results were in question. This is essentially a mighty business of getting results. We shall succeed there as we have elsewhere.

There is every reason for optimism. The game is now of our playing. The enterprise has already begun to turn in our direction, and though the way may be long and hard, we shall win. Of that there can be no doubt.

Public Utilities May Not Pick and Choose

WATER companies and other public utilities should join the gas companies in noting the decision of the United States Supreme Court that gas mains must be extended to outlying communities, regardless of profit, on order of a state utility commission. The court upheld the New York Court of Appeals in sustaining the Public Service Commission of the Second District in the opinion that the Queens Gas Co. could not "pick and choose" between profitable and unprofitable areas, but must extend its services when the evidence convinces the commission that the public interest demands it.

Army Camp Health and Sanitation

ANYONE who is disquieted by reports of high mortality in army camps should remember that the sudden concentration of men from all parts of the country and walks of life inevitably quickens the spread of such diseases as measles and scarlet fever and that these in turn give rise to other forms of sickness. Pneumonia, it should be borne in mind, is now prevalent in civil as well as army circles. It is a subject for congratulation that typhoid fever, which caused such ravages in the Spanish-American and Boer wars, is now conspicuous by its absence. At last the medical and engineering professions have vanquished this scourge. In the present emergency the engineer has been given a rare opportunity for service which he has embraced with eminent success both as to speed and quality. The wise care he has bestowed on various engineering problems is illustrated by the camp water-supply specifications exhibited on p. 33 of this issue in an article by Dabney H. Maury.

Full Publicity for the War's Engineering Developments

ALTHOUGH engineering science has for three years and more filled the chief role in the European struggle, practically nothing of the professional developments and achievement of the war has appeared in the foreign technical journals, and a negligible amount of information has filtered through the Allied censorship to this side of the water. Just as the engineering skill of peace can be used to shorten war, so also can engineering progress made under the strain of military necessity be turned to the uses of peace. Should delay in the recording of these achievements result in our losing them through the death of the men responsible or through restricting the knowledge of them to the few concerned, we would not be able to realize the benefits of this tremendous stimulus that we may rightly expect as partial compensation for the heavy sacrifices that we must make.

Therefore, the engineering profession of this country and the public at large owe a debt to the Administration for its open policy regarding the publication of technical information about the war. About the lessons learned in the development of the great European cantonments the engineering profession at large knows nothing; about our own cantonments it has already been told almost everything of interest. Nothing has been published about the tremendous stimulus to shipyard and ship construction in the British Isles. In this issue is a comprehensive outline of what America is doing at her three largest plants. Much information has been given about the engineering side of war production, of transportation, of the organizations which are purchasing and supplying equipment, and more is coming as fast as the military situation will permit of its publication. A special representative of this journal, Robert K. Tomlin, Jr., has gone abroad with *carte blanche* from every authority and department in our war machine to secure engineering information about our participation in the war though subject to the vise of the French censorship. In fact, it has been said by men in high position at Washington that Mr. Tomlin has gone abroad with the most authoritative credentials given any citizen since the war began.

Nor must it be understood that for this willingness to give the profession anything that can be published without prejudice to the operation of our armed forces we are indebted entirely to the civil government and to the civilian engineers who have been called into the service of the country. The line officers of the force that constituted our old regular army and navy—generals, admirals, bureau chiefs and department heads—have without exception given assistance of the greatest value whenever it has been requested.

In this issue, which contains so much on the engineering conduct of the war, the *Engineering News-Record* wishes to make special commendation of the Government's policy and to record the indebtedness which engineers and contractors have thereby incurred.

The First Motor Truck Convoy

ANNOUNCEMENT has been made of the arrival in Baltimore of 29 of the 30 army trucks which left Detroit three weeks ago, destined for use by the military forces in France. Faced with the possibility of delay on account of the congestion of terminals and railroads, the daring adventure of bringing these heavy machines over the Alleghenies and the Blue Ridge Mountains was tried in full faith that the skill of American designers and artisans, and the perfection of American methods and materials would make success possible in the face of even the most severe conditions. For several sections of the route followed were in no sense improved highways and the certainty that storms, even blizzards, might be encountered gave to the attempt an aspect of rashness.

The expected extremes were met and overcome. Not entirely is this to the credit of the designers, builders and drivers of the trucks. Essential to the happy finish of the journey was the aid rendered by W. D. Uhler, chief engineer of the Pennsylvania State Highway Department, who kept every foot of the route through his state cleared of snow and open to the easy passage of the convoy. Through coöperation that speaks well of the coördination which has been established, the various local officials bent every effort to the work which was so vital and may prove so necessary if we are to keep munitions moving eastward toward our boys "over there." This convoy is the forerunner of many others. The trucks will not only not be a burden to our congested railways, but will carry cargo and afford opportunity for training the motor transport crews for the work that lies before them in France

New Shipyards a Triumph of the Civil Engineer

SOME stories are coming across the Atlantic intimating a degree of doubt among the experts as to the permanence of the standardized fabricated steel ship for peace-time ocean carriage. Whether this be sound judgment or merely typical British conservatism, it can have little effect on shipbuilding conditions in this country. The government here is committed to the purchase of hundreds of such ships and millions of dollars have already been invested in the plants for their construction. For some time, then, the fabricated ship will be a product of American shipyards and the intimate concern of many engineers and contractors who hitherto have not been interested in shipbuilding in any of its phases, but who are responsible for the initial success of the fabricated ship production, that is for the construction of the plant and for the fabrication of the ship steel.

The detail manufacture of the fabricated ship—that is the problem of adapting ordinary structural ship and erection methods to the novel necessities of a ship's hull—has not as yet been worked out to the point where published descriptions are possible or desirable. It reduces in effect to establishing a minimum of sizes and shapes and a simplification of detail adapted to manufacture in the minor structural shops throughout the country, and to erection by structural workers on the ways. But the layout of the yards from which these ships will be turned forth is a completed thing in some of the new and big plants where government ships are to be built. Because they are the largest of the new shipyards and because the different solutions of practically the same problem have comparative interest, the plant layout of the three government subsidized yards for fabricated ships are given in this issue, the first definite description of one of the largest of the new fields into which the war has thrust the civil engineer and contractor.

Under ordinary methods of construction building ships is a tremendous job. Every ship is different, and the whole ship has to be fabricated at the place of erection. This is slow work. One ship occupies a set of ways for a very considerable length of time. The erection is held back and the ways occupied while fabrication of every part is passing through the immediately adjoining mill. Even the largest shipyards can not take care of more than a dozen ways. It is hopeless to expect quantity production.

In the crisis the country needed ships and needed them quick, so the infant idea of the fabricated and standardized ship was brought to the rescue. Under this method ships are turned out faster, because it is possible to get material to the ways as fast as that material can be erected. At Philadelphia, we have fifty shipways, and at Newark, twenty-eight ways, a quite unprecedented number for any one plant and a concentration impossible under a method of fabrication requiring shops for complete production at the site itself.

The problem then of the fabricated shipyard is one of quantity production, of rapid assembling of standard parts. It is the Ford automobile on a tremendous scale. And the laying down of the plants where this can be done has devolved on civil-engineering organizations. What they had to do is set forth in detail for each of the government yards. It is worth while for the engineer reader to compare the solutions and to note the similarities due to basic conditions and the divergencies due to location and size. He will see, for instance, that each plant has its large storage and classification yards with shipways readily accessible, its interposed shops for such local fabrication as is necessary and adjacent readily reached fitting-out berths for the completion of the launched ships. In general, these are the same, but the size and equipment of the shops differ with the percentage of local fabrication required by the ship design, and the control of the shipways, whether by crane runways, alternate-way boom derricks or successive-way tower derricks, is varied to the idea of the designer.

Furthermore, the reader would do well to note the scale of the layout drawings so that he may realize what the construction of one of these plants means and appreciate the labor required to transform such an area from the barren waste of early September to the active construction job of January—to the working shipyard with its ship a week by the anniversary of our entrance into the war. American engineers have in the past few months become so used to construction jobs where ten thousand men work side by side that they have lost the early thrill of wonder and

admiration, but he would indeed be hardened who could today walk over the many acres of any of these new yards where the future freighters are soon to be laid down without a rising pride in his profession and in his fellow engineers who are putting through such a work in such titanic style.

Making Existing Facilities Do the Work—The Railroads' Problem

WHILE millions of dollars have been going into shipyards, ships, cantonments and Government warehouses to take care of the abnormal needs of the war, the railroads have been confronted with the very different but not simpler problem of moving the abnormal traffic created by these expenditures with existing facilities—hampered besides by priority orders, the shortage of labor and the difficulty of getting supplies for ordinary maintenance. To the unthinking the recent taking over of the railroads by the Government will seem evidence that the railroads have failed in this emergency. This is hardly the case. A far larger volume of traffic has been moved in the past year than ever before. There were obstacles that the railroad managers neither made nor were permitted to remove; it is the Government's power to remove these obstacles that offers the greatest hope in the far-reaching change just made.

What, then, have the railroads done? Their special activities date from five days after our entry into the war. On Apr. 11 railway executives representing all of the important lines met in Washington and voluntarily agreed to merge their "individual and competitive activities to produce a maximum of national transportation efficiency." A committee known as the Railroads' War Board was created, composed of five leading railroad executives. The board was given authority to prescribe the policy of operation of the railroads represented.

Many and varied have been the board's activities, and those of the 27 other executive officers on subcommittees. In Washington alone an organization of 500 men was built up. Smaller organizations were scattered through the country. A commission on car service has been studying the problem of balancing the supply of cars against the country's needs, at the same time carrying on educational work to promote better loading and quicker unloading by shippers, and more expeditious handling by the railroad operatives. Rules have been issued urging the conservation of motive power, the prompt repair of cars, the proper loading of trains (as well as cars), the intelligent use of embargoes. Construction work not needed to win the war has been suspended. Unnecessary passenger train and "luxury" service has been reduced.

Through these and other efforts the railroads in the first five months of the war handled 16% more freight traffic than in the same months of 1916, which year broke all records up to that time; more traffic in fact, than was handled in any whole year prior to 1904. And still, with an unprecedented amount of freight clamoring for movement the railroads fell behind, especially in the East. Therefore the board adopted the still more radical, not strictly legal but thoroughly patriotic, plan of operating the Eastern roads as one line, pooling their facilities, particularly terminals. Pittsburgh was made the headquarters of the new organization formed to operate this 120,000-mile railroad. The plan was in effect scarcely a month before the Government assumed control, so one can hardly say how successful it would have been; but it indicates the vigorous efforts made by the railroad managers to cope with the situation.

According to our present-day technical definition, this work of the Railroads' War Board is not engineering. Less than the normal amount of money is being spent on railroad construction. The companies have not had the money to spend, nor could they in any event have secured the necessary labor or deliveries of material. Their problem has been to get along with existing facilities and stretch the capacities of these facilities to the limit. It is interesting, however, that three of the five members of the Railroads' War Board are engineers by training, while one large system in particular has recognized in its management policy the value of such training in railroad operation. In time the thought may, and should, become general, that such work as the board and its organization have been doing these nine months classes with the highest form of engineering.

Government Operation and What It Means

A CHRONICLE of the superengineering called forth in 1917 by the war would be incomplete without the foregoing mention of how the railroads have handled a record traffic with little additional plant, and it is to be hoped that the operating improvements and educational campaigns started by the Railroads' War Board will continue without interruption under government control; but the appointment last week of a Director General of Railroads has changed the entire picture, and thrust the country into its biggest economic problem since the Civil War. Probably the step was necessary; but it has introduced the gravest responsibilities. The properties taken in charge by the government have an estimated value of $20,000,000,000, and the social and political problems that will arise are no less important than the financial.

At the outset we may consider why it became necessary, if it did, for the government to take over the railroads, and wherein government operation will differ from the unified private operation of the last nine months. *Engineering News-Record* perceives that the new plan has greater possibilities than the old, and hopes they will be realized. But it does not feel that the change means that the railroad board failed in emergency, and it hopes that the board will be left in charge.

The chief obstacles which the board could not overcome, but which the government can, are, in the first place, anti-trust and anti-pooling laws, passed long ago to force competition, and the conflicting demands of various branches of the government war organization, against which embargoes could not be placed; and, in the second, returns insufficient to attract capital and make new construction possible, difficulty in obtaining prompt shipments of supplies necessary for maintenance, and the ever-growing labor problems. The Railroads' War Board could carry unification of the railroads to the edge of the law, appeal to the various gov-

ernment departments to harmonize their transportation demands—and pray for the future in the face of prospects far from rosy. The government can ignore the anti-trust laws, force the various war-supply departments to accept what transportation is given them, eliminate the problems of credit and capital for future construction, and settle beyond dispute the demands of labor. At the same time the task of the Director General of Railroads is not a light one.

One of the first of the broad economic problems to be faced is the question of compensation for the railroad security holders. The President's plan of allowing the companies the average net income of three years preceding June 30, 1917, is fair—more fair probably than the owners expected, in the light of the government's attitude in recent years. Yet if followed it will produce gross inequalities. Some important properties have made next to nothing in the three years, and any attempt to condemn them to the same fate for the indefinite future is likely to produce litigation. On the other hand, some properties have had abnormally high returns in the same period, and Congress, seeing this, may be tempted to scale down the entire list. The nut is a hard one to crack.

Closely linked to the question of return to the owners is that of rates. The application of the railroads for a 15% increase has not been granted, yet it is already conceded that this would not be enough to meet increased expenses. Unless government operation, as is hardly conceivable, proves less expensive than private operation, more than the equivalent of the 15% increase must be raised, by higher rates, taxes or both. *Engineering News-Record* hopes it will be mainly by higher rates, so that the railroads will be self-supporting without jugglery of figures.

As the rate question depends on one side on the compensation to the railway owners, so on the other side it depends on the wage problem. The Adamson law appeased the brotherhoods of trainmen only a few months; now they are back with greater demands. On the basis of present earnings and ability to pay, these demands cannot be granted. In the light of the high cost of living and what the public as a whole is willing to pay its employees, they may be reasonable. But it must be realized that these brotherhoods constitute less than 20% of all railroad employees, and the other 80% are less well paid than the 20%. In August, 1916, the government turned a deaf ear to the petition of these 80%. It can hardly do so now—yet a 40% increase to all railroad employees would make a stupendous addition to railroad operating expenses.

All of these matters pertain to the operation of the railroad facilities that now exist. But they do not constitute the whole problem. For a decade the railroads, pinched for capital, have been falling behind in their programs of additions and betterments. If the government is to build for a long war, as it is doing with respect to shipping, it must make up for the past by launching such a program of railroad construction as the country has never seen—not new lines, but multiple tracks, passing sidings, yards and terminals, together with cars and more cars, and locomotives. It must do this in the face of towering prices for materials and labor, and of the necessary demands of other departments of the government for materials. At the same time it must restore the railroads and their rolling stock to their normal standards of maintenance.

Even this is not all, nor the greatest part of the government's problem; the socio-political is the big phase. In two days 2,000,000 individuals, most of them voters, were converted from private to public employees. In other words, 2% of our entire population. Six hundred thousand holders of railroad securities saw the last vestige of their control of their property disappear. Forty odd state commissions were deprived of their jurisdiction over large and small fragments of trunk lines within their boundaries. In war times, when we are commandeering our young men by the million to send to France, this commandeering of civilians and their property does not seem so sweeping. But who will say that the railroads will be restored to private operation after the war? And if they are not, will these millions of employees and shareholders be able to disregard their railroad interests when they come to the polls? And will the baffled state commissions, or rather the citizenry whose attitudes they reflect, forget that they have been baffled? Will public officers and candidates be to a proper degree independent of the power of these votes of individuals and states? Above all, will succeeding administrations keep the railroads clear of the spoils system and in the hands of men trained by experience to run them?

The greater the measure of success that attends this venture, the greater the likelihood of a continuation of the plan after the war. May we be prepared for that if it comes! At present, however, our chief purpose is to win the war, and to that end all must and will join to make government operation of the railroads a success.

War Has Created a New Attitude Toward the Highways

SINCE the war began, there has been a pendulum swing of sentiment in regard to many important questions. Hardly had we entered the conflict when there was a nation-wide cry for economy. This was succeeded by a campaign for "business as usual," followed again by a reversion to an economy program—this time a sane emphasis upon restriction of waste, but without condemnation of reasonable expenditure.

As to highway work, similarly, there has been a swing—not two reversals of opinions, it is true, but merely a reaction against the policy originally advocated. It will be remembered that shortly after the declaration of war many persons, some of them unfortunately in high places, declared that highway work was not essential and advocated its elimination until the close of the war. They had their day and probably helped to hold back highway work during last season.

Fortunately, better counsel quickly prevailed, and in increasing number people of standing with highway officials and contractors have been preaching sound doctrine with regard to the relation of the highway system to the prosecution of the war. Nevertheless, there was so much ill-timed talk regarding the alleged non-essential character of highway work that we must attribute Priority Order No. 2, in part, at least, to it. The publication of that order marked the climax of

the anti-highway-construction propaganda. The order aroused those who understood the highway situation to a sense of their responsibility, and the reaction has been so vigorous that it is safe to say that never before in this country has there been so true an appreciation of the place of the highway in the economic scheme. Railroad men and other transportation specialists who never before were willing to admit that the highway was anything but a potential competitor now are most anxious to coöperate in road utilization. For the first time in our history there is hope of coördinating the steam and electric lines, highways and waterways.

The final mark of a decided change in attitude was the appointment by the government of the Highways Transport Committee, thus giving highways an official status in the war, as well as in our economic scheme.

It is true, of course, that a mere reversion of thought, or even the appointment of the Highways Transport Committee, has not solved the problem. In fact, it has merely made a basis from which we can start an intelligent study of the whole situation and decide how the highway may best be handled for our military and economic welfare.

Real progress in this direction was made when the American Association of State Highway Officials, at its Richmond meeting, called upon the state highway departments to furnish the data upon which a program of war highway work could be predicated. The executive committee of the association will work with the Highways Transport Committee and with the Priority Board, thus aiding the centralization which is necessary for the proper handling of the present emergency.

Various analyses are now being made to disclose all of the factors which enter into the problem. There is not merely the determination of the roads which will relieve congested railway routes. We must look to the labor and material situations and prepare to relieve the contractors of some of the responsibility—the great risks—that we asked them to take during the past season. To continue that policy would be suicidal. There must be some agency which, viewing the problem broadly, will recommend not only the measures of relief but others that are at the same time sound and expedient. Obviously, the Highways Transport Committee is this agency.

While the near future is beset with very obvious difficulties, and can be passed through only by viewing the problem broadly and by the most disinterested coöperation of highway officials, contractors and material interests, the highway outlook for the immediate present as well as for the far future is not depressing. We have the assurance of Judge Lovett, of the Priority Board, that Priority Order No. 2 will be abrogated on or before Apr. 1. In other words, there is reason for preparing for just as much highway work as can possibly be let for the season of 1918.

For the present, therefore, road construction is in a more favorable position than it was in the spring of 1917. The agitation that then held it back is past and will not recur. Moreover, there is such an appreciation of the labor and material difficulties that the states will be obliged to take over some of the elements of chance, assuring withal a more stable condition next season than last.

Moreover, the agitation regarding highway work has produced a very beneficial effect for the future. For all time the place of the highways in the transportation system of the country is settled. This is a real gain and one that those who have the interests of highway development at heart should not belittle. In the past there has been inveighing against "pleasure roads" and ill-concealed prejudice in some quarters against motor transportation. That is definitely and finally dead. Highways are an economic necessity for the nation. Sensible men have known and recognized it for a long time. Now the country at large has been forced to its recognition and, insofar as that recognition has been secured, all the stress and strife that we have passed through during the last year have been more than paid for.

This accomplishment—the placing of the highway system of the country in its correct economic and military light—will mean for highway development after the war is over an expansion such as we have never dreamed of in the past. We have been looking with amazement at the increase in expenditures for highway work during the past decade. Who can doubt that these are the merest beginnings when measured by the development that will come after the war is over.

Municipal War Programs Needed

UPON our cities rests the major burden of winning the war for democracy, for in them is concentrated by far the larger part of the population, industry and wealth of the country. In proportion to their population, industry and wealth, our cities are doing at least their part in the war, but as municipal entities few of them have yet made a beginning in well-conceived and efficiently executed war programs.

Municipal War Programs—By a municipal war program we mean a plan of strictly municipal activities and economies that will contribute the utmost in helping win the war. When citizens are being called upon for great war sacrifices it is imperative that the municipal government keep the strictly municipal burden as light as is possible. At the same time it is doubly imperative that municipal services, essential for daily existence and health under city conditions, be maintained at a high state of efficiency. It is also certain that the number of these services will be increased rather than decreased during the war period. To meet all the demands upon it and still keep the financial burden within limits demands judicious and comprehensive planning.

Municipal war programs should cover at least three and preferably five years. They may be recast with ease if happily there be occasion to do so within a shorter period. Whatever the length of the war there is bound to be a period of readjustment which for the present can best be included in a war program. For some municipal services a program of more than five years' duration is desirable. It should be remembered that, war or no war, a municipal program covering several years is essential to efficient service and orderly and economical city growth.

Budget Making Needs Attention—The elements of a municipal program have to be weighed and balanced against each other and the vital needs of the city in

terms of cash. So hand in hand with a municipal program for war times should go a carefully considered municipal budget, showing a functional distribution of anticipated yearly receipts and proposed expenditures for the coming year, compared with actual yearly receipts and expenses for the past three to five years. Few American cities have even a near approach to such a budget. Through lack of it ill-advised expenditures are authorized and, worse yet, no sound financial provision to meet them is made. The budget should show where the money to meet its demands is coming from.

Municipal Bond Market Important Factor—A pay-as-you-go policy as regards municipal improvements is doubly commendable in war time, because it drives home at once knowledge of the fact that obligations are being incurred and makes the taxpayers question their wisdom. All improvements cannot be financed by taxation. The municipal bond market, through both internal causes and advice from Washington, is already discouraging new issues of municipal bonds. This is bound to increase. Consequently, city improvements must be materially checked or tax rates already growing burdensome be increased or else some other way of financing city improvements must be utilized. An extension of the assessment-for-benefit plan suggests itself as being well known and bringing right home to those who must pay the bill the wisdom of incurring it. Many cities will find, on investigation, that they have a perfectly free hand, legally, in carrying this form of assessment much farther than they have yet done.

Health Needs Paramount—Non-essentials must be cut out and with them must go some things that may at first thought seem essential. It is imperative to the successful issue of the war that the health of every man, woman and child be maintained at the highest possible level and the death rate be kept to the minimum. With more than half the population of the country centered in cities and with all the chances for the spread of disease among concentrated populations, city health problems must be given more extensive, more intensive and more intelligent attention. No municipal service essential to the public health should be discontinued or crippled.

A true conception of what activities performed or regulated by the city really affect the public health is now more essential than ever. Many cities are spending money in the name of health which brings no health returns whatever. Such expenditures should be ruthlessly cut out—or if justified on other ground than health should be transferred to their proper place in the budget classification and also in the administrative organization. They will then be judged on their face value instead of being considered behind the false mask of health needs and, so far as retained, will be in charge of the department equipped for the specific task.

Sewage and Refuse Disposal Projects Should Be Rational—In the aggregate, the expenditure of large sums are constantly being urged in the name of public health for sewage treatment and for the disposal of garbage and other municipal refuse where little if any direct benefit to health would result. Such projects should be considered on their merits. Many can readily be postponed. Others can be so modified as to cut their cost to half or less. A secondary but material advantage of postponement of sewage treatment will result from the added knowledge meanwhile obtained regarding some of the newer and promising methods now being tested.

The country is dotted over with sewage-treatment works and garbage incinerators, some of which should never have been built, while others are not suited to local conditions. A large percentage of both classes are improperly operated. A well-conceived municipal war program would prevent some of these costly errors and rectify others.

Garbage Should Be Utilized—Although the expenditure of money for garbage disposal in the name of health is not justified, there is strong argument for its utilization as a contribution to the food, fat and fertilizer supply of the country. Any city which is not either sending its garbage to a piggery or a reduction plant should lose no time in having an engineering study made as to the local possibilities of the two processes with a view to putting one or the other into effect. A garbage piggery can be installed in short order and at comparatively small expense and the major part of the investment—pigs—can be turned into cash at a moment's notice. Burning garbage in these times of food, fat and fertilizer scarcity is little short of criminal, unless local conditions are against feeding to hogs or disposal by reduction. Other forms of municipal refuse, such as paper, may also be recovered and sold.

Stop Water Waste—Hundreds of cities are permitting water to go to waste which, if saved, would reduce operating costs, increase pressure and postpone costly extensions. The remedies are waste-water surveys and the installation of meters. Besides cutting down useless and harmful waste, meters afford the only just means of apportioning the cost of a public water-supply among the consumers, which alone is convincing argument for their use in these times when every man's burden should not only be kept to a minimum but should also be as equitable as possible.

The Paving Problem—The municipal war program should give due recognition to the fact that the quick and economical movement of material, and perhaps troops, essential to the winning of the war will depend largely upon the provision and upkeep of suitable pavements on through and feeder-traffic streets. In some communities this sort of argument may be given too much weight in the endeavor to get improved pavements at general city expense on residence or minor traffic streets. A judicious application of the practice of assessing the cost of the pavement upon the property directly benefited will often prove wholesome. In the case of badly-worn existing pavements, careful attention should be given to the advisability of continuing even heavy maintenance charges rather than providing new pavement, in order that materials and capital outlay may be conserved during the war period.

Catching Up and Planning for the Future—For one or another reason, engineering construction in many of our cities will be at a low ebb for a time. This will afford municipal engineering staffs an opportunity to bring much needed plans and records up to date. They may go further and collect data and make plans for future work.

All this can be done without any drain upon the bond market, construction materials or transportation, and

without any addition to the permanent engineering staff. In fact, much of this work can be accomplished with even a depleted staff. Thus a nucleus of an engineering staff can be retained and kept in training for the rush of work that must follow a period of low construction.

City Planning and Zoning—In the last five years scores of American cities have for the first time in their history given official attention to city planning. This should be increased and accelerated. It involves little expense and may be made to save millions in the future, besides adding immensely to the health, comfort and uplift of the people. While the advice of an experienced city planner should be secured, most of the work of city planning is in the domain of the engineer. He should seize the moment to press home upon the city authorities the need and the present opportunity for city planning.

Zoning, or the division of a city into residence, industrial and business districts, is an important element of city planning and one that can be not only worked out but also put into effect with a minimum of expense. Hundreds of cities might well seize upon the present time to make the needed studies and prepare and pass the required zoning ordinances.

Increase Municipal Efficiency—Efficiency in municipal administration must be increased if the war is to be quickly won and its burden minimized. This means reform all along the line. It means, first of all, that the fittest men available must be selected to fill each official position and that once there they must be kept in office and permitted to do their best, regardless of political or any other consideration. It means that city work must be planned, financed and executed along the lines indicated in the foregoing paragraphs and that engineering advice must be sought and followed by municipal authorities, as urged in *Engineering News-Record* for Nov. 15, p. 908. It means, for many cities, the adoption of a more efficient system of government, with a clear separation of legislative and executive functions, and a centralizing of executive direction in the hands of a single, competent man. Finally, it means service and sacrifice for the city on the part of each and every citizen.

The Contractor During the 1917 Season

CONSTRUCTION during the past season has not changed so much in volume as in character—from building and public work, as generally understood, to war construction. This trend is borne out by figures which indicate that, while building permits issued this year have declined 35 per cent. or more from those of 1916 in value, the cost of construction actually started will have increased about 10 per cent. Considering all the construction under way for the War and Navy Departments, it is easy to see why the larger contractors, especially near the sea coasts, have been extremely busy. The cantonment work, the great activity of the Bureau of Yards and Docks of the Navy Department, construction in connection with shipyards, and industrial housing and plant construction for war industries have to a large extent replaced city building, small public improvements, street and sidewalk work, and similar construction.

This has been due first to the disinclination of the smaller owner to build at present prices, and second, to the increasing difficulty of obtaining funds. The financial requirements of the Government are making themselves felt in the money market, and there is less and less to invest in real-estate mortgages and in bond issues. New securities issued during the first eleven months of the year declined from more than $2,000,000,000 in 1916 to less than $1,500,000,000 this year. In addition, the price of bonds of all sorts has declined appreciably, and far fewer sales are being made than last year.

It is evident that the small contractor is the first to suffer from these conditions. The contractor who depends on ordinary building construction has, in most cities, done the smallest annual business in many years, while the municipal contractor for water-works, streets, and such improvements, has suffered similarly. In addition there has been added the difficulty of predicting the cost of work in advance, because of continually rising prices and growing labor scarcity. The situation in this respect appears to have been at its worst in the highway field, with the result that many important lettings during the year were almost unattended, and lump sum bids were difficult to secure. The Federal Government in its work has been able to meet this situation by entering into emergency contracts, which make it unnecessary to guess at the cost of work beforehand. There is no legal precedent for this, on the other hand, in the case of public work not of an emergency nature.

The small contractors, however, are not the only ones who have suffered by reason of the rise in costs. One notable group of large firms, which is generally understood to have sustained considerable losses from this cause, are the contractors engaged on the New York City subway work. In fact, except for the unusual financial strength of these firms, it is probable that New York would find itself unable to put its new subway system in operation until after the war. Other large contractors throughout the country engaged in work let some years ago have had the same experience, and it has become almost as difficult as with small city work to let a large contract on the basis of predicted cost. The most notable recent example is, of course, the Miami Conservancy District, where the district itself was obliged to take over the construction because contractors would not take the risk. The large firms have preferred, both from patriotic and business reasons, to undertake Federal Government work on which, while they were able to make little, they were almost protected against loss.

It is evident that the makers of construction equipment have not suffered from these conditions as much as the contractors, although high prices have given them some cause for anxiety. With the volume of actual work under way, while not record breaking, at least equal to that of 1916, these firms would have been well employed in any case. In addition to this, many of them have, by slight changes, been able to convert their plants to make for the Government supplies not of a strictly construction nature. Others have sold a large amount of their regular peace-time products to the Government for use on work for our expeditionary force in France.

With regard to next year it is evident that the tendencies shown during 1917 will continue to grow. In spite of price fixing it will be difficult to keep wages and material costs from continuing their climb as long as the supply of money is increasing. Although including steel and other commodities which have been regulated by executive order, the commercial indices of commodity prices have continued their rapid climb during recent months. It is easy to understand this when we realize that there is now in circulation $48.50 per capita in currency, as against $34.53 at the outbreak of the war, and that this figure is an increase of nearly $1.50 over that for November.

While no relief from high prices is in sight, however, it is expected that a large amount of work for the Government on which the cost will not have to be predicted in advance will be offered during 1918. The Government is said to require at least $1,000,000,000 worth of new military construction. This figure almost equals the total amount of private building for 1917. It remains to be seen whether, having taken over the operation of the railroads, the Government will take any steps to carry out the most seriously needed improvements involving construction work. If this is done, it appears likely that the railway organizations will handle the work as in the past, except that there is little prospect of their being able to get any work done on a fixed cost basis.

On the whole, it seems likely that with the highway work of the country and the industrial housing situation being taken up by the Administration, enough work will be offered to keep the plant and money of the contractors of the country engaged. There is no doubt that more than enough work will come forward to keep all the construction labor available fully occupied, and that the makers of construction equipment, if they go after war business, will be fully engaged.

American Engineering Progresses

THE achievements of American engineering during the year just closed are of brilliant promise. They give a warranty for the power and efficiency of future civil-engineering performance. They demonstrate that the engineer's art is advancing steadily—as fast as in the greatest years of its prior history. There is inspiration in the record.

The details of the year's engineering have already been written. When we look for the larger meaning of what has been done, unfailingly we turn to the greatest works to find a measure of progress. Two of these stand forth, one completed during the year, the Catskill aqueduct, and the other well begun, the Miami flood-protection enterprise. Each contains a wealth of performance. But whoever is free to study them closely will find that they reflect not only the state of the engineering art but as truly the attitude and qualities which the engineer brings to bear on his problems.

In these two remarkable works we see preliminary study carried out in most scrupulous conscientiousness, analysis blending theoretical attack with experimental correction, design that combines efficiency with caution and economy in a manner characteristic of genius, construction directed with regard to results and fairness—but each single element speaks not alone for the qualities of those at the head of the enterprise but equally for the mental temper and equipment of the country's engineering profession as a whole. Let anyone study these great enterprises sufficiently to recognize the elements just indicated; let him then make comparison with earlier works, and he will find that an inspiring progress is shown by the engineering of the present year over that of earlier date.

Something hardly tangible but yet forming a most important part of the year's achievement may be perceived in the works mentioned; namely, distinct advance of the art toward greater efficiency and greater resource. Nothing is more characteristic of the trend of engineering development than this advance. The war stimulus has if anything intensified it. Under the pressure of half-voluntary, half-enforced economy the previously existing drift toward full-efficiency design, full-efficiency engineering, has been wonderfully promoted. The fruits of this progress are barely discernible at present, but they will appear fully in the future.

Another and more detailed view of the year's progress may be obtained if we consider two distinct phases of performance in the year 1917. It may lead to at least partial appreciation of what the profession has achieved in the recent past, and thereby to due recognition of the strength and vitality of present-day engineering.

Bridge construction has marked an epoch in its history. American engineers have gained the splendid distinction of supremacy in every branch of steel bridgework. Never before, since the first iron bridge was built, has one single country stood clearly at the head in this field. Today, with the completion of three remarkable structures, at Quebec, Sciotoville, and Metropolis, America possesses the greatest of each type of steel bridge.

The Quebec bridge leads the list of cantilever spans. More than this, it is the longest span of any kind that the world has seen. Completed only a few months ago after a long history, a history as dramatic as engineering can ever furnish, it finally displaces the famous old Forth bridge, for thirty years the world's most wonderful bridge. Exceeding the Forth by only 100 ft. it might possibly be thought less great a work for today than was the other for its earlier decade. But who that has had any contact with the Quebec work does not feel and know that, in creating it, brain and hand wrought with an effectiveness never surpassed in any generation or age of bridge building.

The type-expression of modern bridge engineering, on the other hand, the simple truss, has been carried forward into a new range of magnitude by the long span of the Metropolis bridge. So, in a measure, this structure is the most accurate representation of our progress in bridges. Characteristically American, long-span pin-connected construction is true to its best promise in the Metropolis bridge—the culmination, we may consider it, of over half a century's steady advance in wrought-metal bridge construction.

In sharp contrast with this development of established practice, the Sciotoville bridge enters a new domain. Its continuous construction, in itself using old ideas, is applied in courageous and farsighted way to long-span work, and opens a broadened range to

bridge thought. In a short time the Allegheny River bridge of the Bessemer & Lake Erie Ry. will stand as a companion to it; together, the two firmly fix the continuous bridge among approved types, and add to the bridgebuilder's equipment an important resource, one likely to play a prominent part in the work of the future.

America thus has the greatest suspension bridges, in the three East River structures at New York; the greatest cantilever, in the St. Lawrence bridge at Quebec; the greatest steel arch, in the Hell Gate bridge at New York; the greatest continuous bridge, in the Ohio River bridge at Sciotoville; and the greatest single span, in Metropolis, also over the Ohio.

With this clear supremacy as regards the major types of bridge, it is only secondary that in steel viaducts, in bascules, in lift bridges and in swing bridges we have equal supremacy. But it is indeed vital to note that this superiority in size which has finally been gained during the past year is merely symbolic of corresponding excellence in all the ramifications of bridge design and construction.

The art of tunneling—an art of patient, careful digging rather than of spectacular performance—has no such record to exhibit as that of bridge-building. Yet there have been two events in this field during the year that represent unmistakable progress. One of these involves innovation while the other is the mere perfecting of practice; and the latter is in this instance the more important.

A tunnel of new kind was completed at Cleveland, the first subaqueous soft-ground tunnel built of segmental concrete blocks. Three miles in length, it is no mere experimental construction but an undeniable full-scale demonstration of the new type. It has a checkered history, and, it may be added, this history is itself a real contribution to the records of tunneling. But apart from any detail scrutiny or criticism, the fact remains that a radically new tunnel structure has been proved feasible, and that a new resource has been added to the art, perhaps new possibilities opened up. Within a few weeks past the same tunnel construction has been recommended by one of the country's prominent engineers for use in what, if carried out, will be among the most remarkable and also difficult river-tunnel enterprises ever attempted—a tube of record-breaking diameter under the Hudson, at New York.

A more significant performance, however, was the quiet and uneventful completion, wholly successful in every detail, of four shield tunnels at New York, driven through typically hazardous river-bottom soil. What is remarkable about this work is the very fact that it went through without incident, almost as a piece of routine construction. Not much more than a dozen years ago, tunneling under similar conditions was justly considered to involve such dangers and difficulties as to tax engineering ability to its very limit. Today the same work is brought down to the level of the ordinary. Thus do the tunnels completed this year bring to light the fact that tunnel constructors have won complete mastery over the formidable problems presented by soft-ground river crossings. An achievement not unworthy of admiration!

The voice of the times tells of new demands to be made by the future, and one of these is fuller and better-utilized intercommunication between men. We cannot doubt that means of communication will be created on a greater scale than in the past, and that the removal of river barriers by the construction of bridges and tunnels will be required to an extent that can hardly be realized in full at present.

Because the prospect of the future suggests that the civil engineer's skill will be called upon to deal with more and greater problems, it is inspiring to see excellence and progress in the achievements of 1917. They give assurance that the engineer is prepared for the work that will be put upon him, and prepared in carrying it out to satisfy the highest demands for efficiency in utilizing resources and meeting the world's needs.

Labor—Shall It Be War or Partnership?

AT PRESENT many grave industrial disputes point toward a labor crisis which, coming in the midst of the greatest stress and danger, threatens our very existence. This crisis must and will be passed through safely. Out of it will come, if indications of the leaven that is already working among us are to be trusted, an adjustment of the investing, managing and working interests that will result in such an increase in production as to make us the first producing country, to the advantage of each of the interests affected.

Most of the readers of this journal are familiar with the history of industrial development. We have inherited from the eighteenth century an industrial system in which the capital is supplied and the managing done by a relatively restricted class. They looked on labor as something which entered into their products in the same sense as did material, and which was to be bought and paid for the same way. But labor had intelligence, which material lacked, and consequently had the same faculty of organizing as did their employers. The men were not slow in using it to organize themselves in an effort to secure more and more of the products of industry. If the employing classes had faced the situation at this stage and taken the workman into partnership, to which he was entitled in proportion to his intelligence, the present situation would never have arisen. But such a course was against precedent. If the men, working on more meagre information as to the operation of economic law, are to be blamed for the many grievous blunders in wielding the power of unionism, how much more are the employers to be blamed for the initial blunder?

Nevertheless, they made it, and many more in kind followed, attributable to both parties to the controversy. One effect was the limiting of individual output. The dispute over scientific management did not follow Taylor and Emerson and their teachings. We find evidences of it among the old English and Flemish guilds, many of which limited production against the loud protests of their employers. The crux of the matter is that the workman saw and still sees in increased production no benefit to himself. He must be shown that he will benefit before he will throw himself unreservedly into production. When that has been done, the reason for unions, as they exist today, will vanish, and unions, as we know them, will vanish too. The three great human elements in industry, the manager

and investor on one side, and the laborer on the other, will have less cause to fight. They will be partners.

Of course, the aims of these classes can never be identical, and the "workers' share" will always be a matter for bargaining. A profit-sharing, or partnership basis of some sort, however, creates machinery for adjustment through which the worker eventually will come to realize his share of responsibility.

The practical obstacles, arising out of the nature of employment and the conduct of the business in many industries, are many and great; but they are being overcome, and none will prove insurmountable. Years ago a few of the wisest, and hence most truly selfish, of employers recognized and put into practice in their own business this principle. As a result, there are in this country today industrial plants where the workers do not want a union organization to combat the management. They do not want an organization for the purpose of interfering with their own business. The business is theirs, in the same sense as it is the business of those who have put their money or their managing direction into it. The workman's efforts are not bought by the hour, but are paid for by a share of the income, in proportion to the effort the workmen put in. The labor turnover in such plants is next to nothing, and in many of them the workmen have been able to make substantial contribution both to the management and to the capital of the enterprise. They are organized, but not for the purpose of combating the business. They have gone a step beyond, and are organized for getting the most out of the business by putting themselves into it in the most efficient way.

This partnership, is, in the last analysis, the ultimate object of labor. The reason that no form of unionism has ever yet realized or expressed this object is that unionism has had to fight hard against management and capital to get anything at all; and that the first things fought for were naturally those most possible at the moment—increased wages, shorter hours and recognition of the right of the workman to combine.

The success of the partnership plan will be found to exceed the greatest expectations. How far ahead we should be of Great Britain, which has begged the question by the establishment of an armed truce for the duration of the war—a truce in which, every now and then, teeth are shown by either side. Or of Russia, which has embraced that alternative to industrial partnership, a socialistic state in which the working class dictates to the investing class and employs the managing class.

And what of all this for the engineer?

He is the creator of the present industrial order. His is the development of power and of materials upon which our industrialism rests. The physical surroundings and the processes which condition the employment of labor are the product of his genius. He has created these things by the application of the scientific method. Now the call is for him to recognize his whole responsibility in production—not merely for materials and machines, but for the labor of men. To that phase of the problem, too, must his scientific method be directed, to the end that every factor may become known which influences human efficiency and so affects production and production costs. And when these factors are weighed, the place and method of a partnership between employer and employee will stand out boldly.

The problem is a mighty one. The engineer can solve it if he but address himself to it in the proper spirit. Will he grasp his opportunity? Will his education be changed to meet the need? Will his societies recognize the situation and do their part?

Few New Engineer Commissions

WE HAVE had inquiries recently asking whether the Government now has place in its military branches for the services of an experienced engineer. The men making such inquiries, as a rule, are well over draft age and have such established business and family responsibilities as to make any military service a more than ordinary sacrifice. They feel, however, a real obligation to their country, and the army and navy seem to be the most obvious channels for service. Naturally, being of mature years, judgment and experience, they feel that they should be commissioned, or at least should be permitted to submit themselves to the usual and proper preliminary training and examinations leading to a commission. They decidedly do not fall in the skilled mechanic class needed by the several engineer regiments now being recruited.

As far as can be learned, Washington can now offer little encouragement to such men. The Engineer Officers Reserve Corps of the army has been closed for some months, and will probably not be reopened, unless the army increases far beyond the present expectation. Probably some qualified engineers will, from time to time, be commissioned to the higher ranks by special appointment, especially for engineering work in the non-engineering corps, but practically all vacancies will be filled by promotion, the lowest commissioned grades from the enlisted ranks.

For younger engineers there is still the opportunity of entering the Engineer Corps that has existed for some years, that is, through regularly held examinations. In order to take these examinations the law requires the candidate to be an unmarried citizen between the ages of 21 and 29 years, who must be graduated from an approved engineering school. The next examination of this sort is to be held Jan. 21, 1918, for which arrangements have been practically completed. Another examination will be held next June or July and information concerning it can be obtained in a short time from the Chief of Engineers at Washington.

Up to the end of 1917 there was a chance for a commission in the Civil Engineering Corps of the Navy, but appointments to that reserve were closed on Dec. 31, with many thousands of applicants to fill the few score of positions contemplated. There seems to be small chance of any further opening here.

The conclusion from these facts is that the engineering profession has responded to the military call of the country beyond the immediate need. As things are today, however, there is very little engineering work in progress which is not in a broad sense necessary to the conduct of the war. Military requirements being satisfied, therefore, no working engineer beyond the draft age need feel that his *engineering* services are not contributing to the nation's need.

Three Government Shipyards Huge Problem in Plant Layout

Building Fabricated Steel Ships Largely an Assembling Operation Requiring Yard Arrangement to Minimize Movement and Reduce Congestion—Design of Government Plants Totaling 90 Shipways Completed Since War Began and Keels Now Being Laid

THE United States Government is to become the greatest shipbuilder in the world. Not only has it commandeered hundreds of vessels on the ways and at the fitting-out docks, and contracted for the construction of hundreds more at private yards, but it has under way three yards of its own, yards where 90 commercial ships may be on the ways at one time, and where about 1,000,000 tons of shipping will be in various stages of construction. These yards are about ready to start operation—in fact, some keels have already been laid down, and by the end of 1918 a large proportion of the 310 freighters projected in the plants will be on the high seas. And yet four months ago the sites of two of the yards were vacant wastes, and the third was occupied by a foundry for the making of cast-iron pipe.

All of the Government shipbuilding is under the direction and control of the United States Shipping Board, acting through the Emergency Fleet Corporation, to which has been delegated the execution of the construction program required by the war. The Shipping Board itself is, in the words of the first annual report, "a part of the administrative machinery of the Government designed in times of peace to promote the development of an American merchant marine and to regulate foreign and domestic shipping."

One important duty of the Corporation, then, is to represent the Government in its contractual relation with private companies. In this capacity, on Dec. 1 it was supervising the building of 1118 vessels in 116 shipyards distributed throughout the United States. But in addition to this it is building, through three agent companies, the three large shipyards where ships will be built under Government direction with Government money. All of the vessels will be the much-discussed "fabricated steel ship" design, in which structural steel shapes fabricated at bridge and structural shops outside the shipyard will predominate.

These three yards and the ships to be constructed therein are built under the agency plan. That is, the Government is in complete control; it furnishes the money for the yards and the ships but employs three companies as agents, on a fee basis not announced, to do the actual building. The yards and the agents are as follows: Hog Island, Philadelphia, American International Shipbuilding Corporation; Newark, N. J., Submarine Boat Corporation, and Bristol, Penn., Merchants Shipbuilding Corporation. The arrangements with these companies were not completed until late last summer, and construction work followed miraculously close upon the speedy organization of the designing forces.

The fabricated ship is not a development of this year, but it is a development of the war. The Merchants Shipbuilding Co., at its Chester, Penn., yard has been building such ships for a year past, and in England the method has been developed in a minor degree. But the three new Government yards raise the manufacture of such ships to a standard industry.

The nature of the fabricated ship must await treatment in a future article. It will suffice to say that the design, which varies in detail for the ships being built in the three yards, has a simplified and almost rectangular hull section for a maximum length of ship, in which are used shapes and plates which are standardized and made up of ordinary structural material capable of being fabricated in any structural shop. The stern and bow sections and additional extraordinary fittings, making in all from 5 to 30 per cent. of the steelwork of the ship, depending upon the type of ship, have to be rolled from so-called ship sections, or of such shapes and in such form as to require a special shop. These shops are a part of the shipbuilding plant. All lumber and other fittings, and all boiler and engine equipment, will, so far as possible, be manufactured in separate plants, as a contract job, and be shipped, ready for installation, to the shipyard.

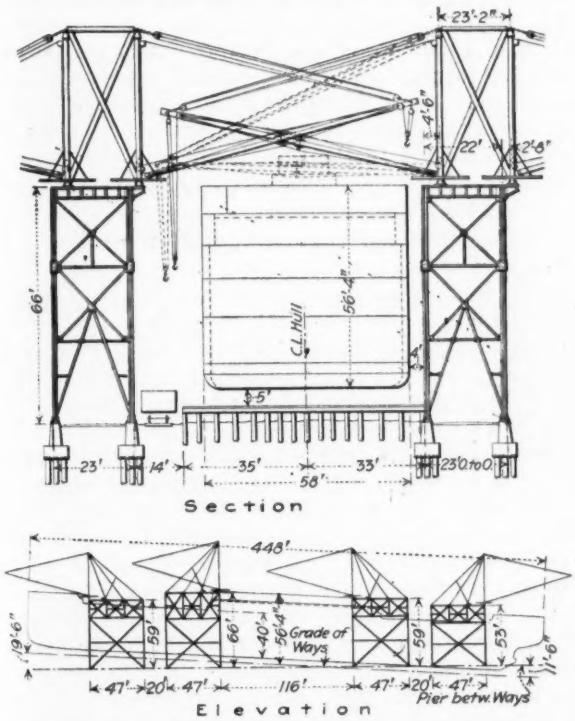
The problem in the fabricated shipyard, therefore, becomes one of assembly, with its contributing problems of routing, handling, erection and riveting. The designer must provide a railway yard capable of receiving a vast amount of fabricated and manufactured material and distributing it as required to a long line of shipways on which is going on simultaneous construction of many similar ships—at the same time providing shops through which will pass, without interference with the fabricated material, that proportion of the ships' frames and fittings which requires manufacture at the yard. How the problem was met at each of the three yards is outlined in this article.

American International Shipbuilding Corporation, Philadelphia

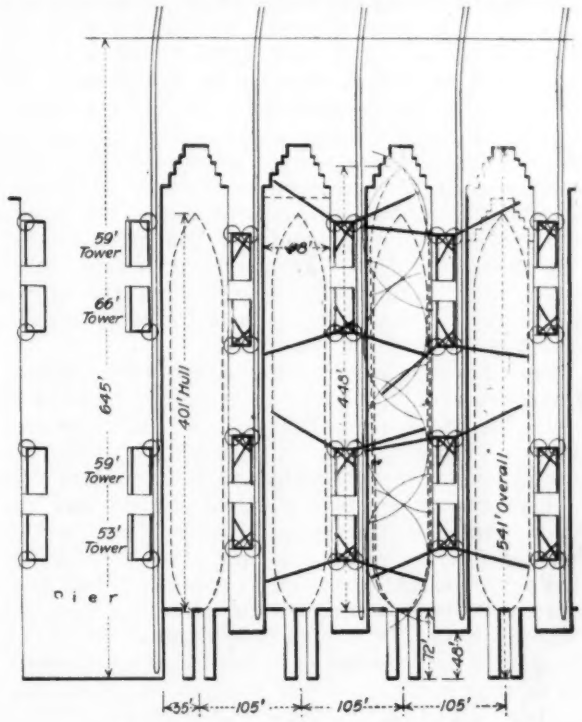
THE largest of the three yards is the one now being built on the Delaware River at Hog Island, Philadelphia, for which the American International Shipbuilding Corporation is agent. Here, along a mile of water front, will be 50 separate ways on which will be built simultaneously 50 steel ships. Downstream for another mile is a wet basin, where 28 ships may lie at seven piers while being fitted out. In the next 18 months it is intended to build 120 freighters here—that is, a 7500- or 8000-ton ship every five days.

Hog Island is no longer an island, though there is a back channel reaching in from the Delaware River

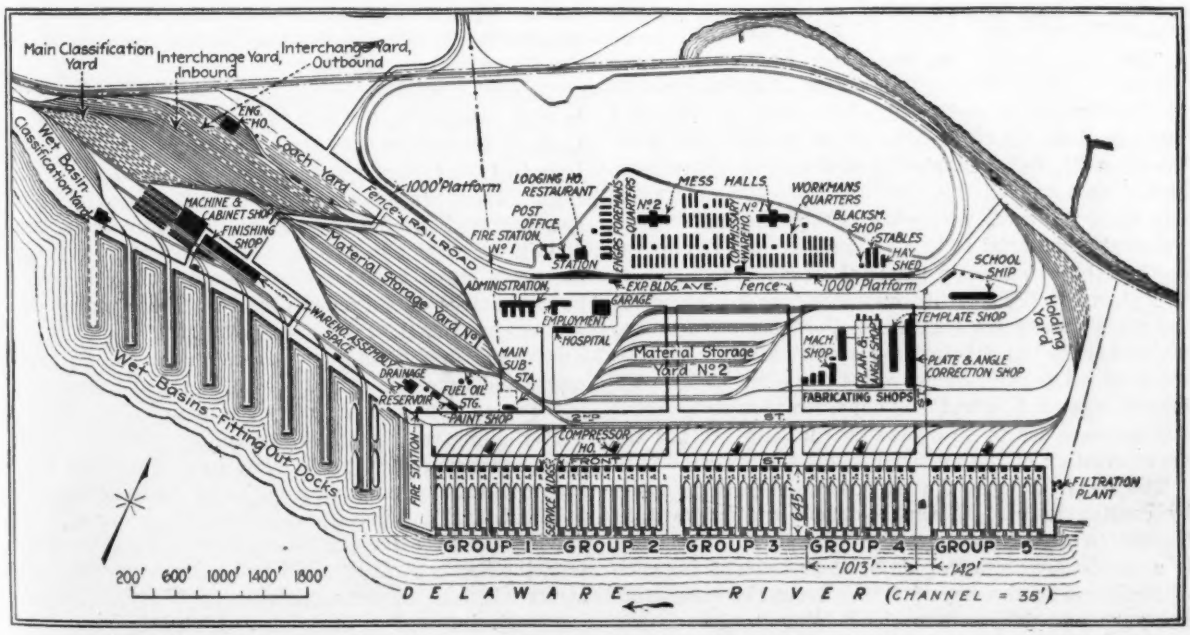
at the north end of the site. That part of this channel which will interfere with the work of the yard is being filled in, so that the entire site will be connected by land to the mainland. In addition, an area of considerable extent at the lower side of the site has been diked and is being filled up to grade by hydraulic fill pumped in from dredges engaged at present in excavating for the wet docks and for the launching area immediately in front of the ways. The yard is situated on the west bank of the Delaware River about seven miles south of the Market St. wharf in Philadelphia. When taken over by the agent in September, it was a wilderness overgrown with heavy underbrush and small trees. Today the whole 900 acres have been cleared, all of the 50 ways are under construction, dredging operations are under way in the wet basin, quarters for 2500 workmen are occupied, and the construction of the yard and shops is proceeding at a satisfactory



Derrick Control of Shipway



Detail Plan of Part of Shipway Group



SHIPYARD AT HOG ISLAND NEAR PHILADELPHIA FOR AMERICAN INTERNATIONAL SHIPBUILDING CORPORATION

rate. To accomplish this has required an average working force of from 12,000 to 14,000 men, some of whom are housed in the cantonment type of building on the work, but many of whom, living in and around Philadelphia, reach and leave the plant every morning and evening on special trains and boats.

The general layout of the site is shown herewith. The railway tracks from the north or from the west lead to a station at the middle of the site. Grouped around this station and to the north and outside of a fence inclosing the yard proper are the residence buildings. These, as at present designed, include a lodging house and restaurant, quarters for the foremen and engineers, mess halls, quarters for the workmen, stables, blacksmith shops and warehouses for the commissary. All of these buildings are of timber construction and may be enlarged in number as the work progresses. Immediately opposite the railway station but within the yard proper is the administration group for the operation of the plant. These structures include a large frame wing building for the main offices and an employment office immediately at the entrance to the yard, and garages, hospitals, etc., near-by.

From the main entrance wide streets extend serving the entire yard, so planned as to permit free use of motor trucks for transporting material and other yard service. The yard will be thoroughly sewered, the sewers running to a disposal plant on the western side. A high-pressure pumping station is located near the shipways, equipped not only for general yard service but for emergency use and fires as well. The fire stations are carefully planned to cover the whole yard and are equipped with complete apparatus of the most improved type. From rapid sand filters at the end of the yard a water system extends with sufficient capacity to serve a city the size of Minneapolis. Electricity for the plant will come from a local public service company.

Only Five Per Cent. Fabricated at Yard

The operation of the plant may be followed from the layout plan. The design of the ships to be built at Hog Island is such that about 95% of the shop work is done in fabricating shops outside the plant, the other 5% being fabricated at the plant in the shops at the east end of the site. All material enters the site from the west, where are located the main yards. Fabricated material is brought in here and run to one or the other of the two material storage yards, where it is stored in the space between the tracks. Alongside the main tracks are tracks for the locomotive cranes which handle the fabricated material after it reaches the yard. The main-line cars then are run back to the interchange yard, to be taken out when required. About 500 flat-cars are to be owned by the shipyard for the transportation of the material inside the yard.

The material from the main storage yard is taken by continuing east to the so-called holding yard in the extreme northeastern end of the plant. This yard is a day-to-day storage. Material as ordered for each of the ships on the ways is taken from the main storage yard and delivered to the holding yard each day for the construction of the ships on the next day. In this holding yard are run tracks which lead to the individual shipways. Material can be taken directly from the holding yard to the ways. In addition, tracks are run from the material storage yard directly to the marginal tracks controlling all of the shipways, so that in case of necessity materials can be delivered directly from the storage yards to any shipway. The yard contains about 75 miles of standard-gage track.

Between the second material storage yard and the holding yard are located the fabricating shops, which for the time being will be of temporary construction—that is, steel framing will be kept at a minimum. Material enters the shops from tracks on the south side of the shop area, passes through the fabricating shops, and is delivered for use in the ships on the tracks at the north side of the shops, from which tracks it can be delivered to the west to the material storage yard, or, if wanted immediately, to the east to the holding yard.

Heavy Fittings Brought To Wet Basin Area

The heavy fittings and timber for the finishing of the ships are brought in from the west, but are classified and stored in the wet basin classification yard in the extreme southwest of the site. From this yard the material is run into the machine and cabinet shop or the finishing warehouse, and is then delivered by locomotive cranes to the fitting out wharves which control the ships in the fitting out process, or is delivered direct to the wharves from the classification yard.

The ways are laid out in groups of ten each. Each way is under independent control, but the groups of ten are each served by a compressor house located at the center of the ladder of tracks entering the ways. As in the other Government plants, however, the construction of each ship on the way will be in charge of one foreman, who is responsible for the work on his ship or on his way, and the control of that way is independent of all the other ways. Each foreman will order his material for delivery as though he were conducting an independent plant, and it will be forwarded to him through the track arrangement noted in the foregoing paragraphs.

There are two different types of way, differing mainly in size, Groups 3, 4 and 5 being able to take care of boats of larger size than those in Groups 1 and 2. The layout of the typical ways is shown in one of the drawings. These ways are spaced on 105-ft. centers and are 400 ft. long for the 491-ft., 7500-ton boats, and 450 ft. long for the 541-ft., 8000-ton boats. Between each two ways are four steel towers, each carrying boom derricks on its outer corners. These towers are stationary, but their booms are of such length as to control the shipbuilding operations on the two adjacent ways, and they are spaced off center in the inter-way space so as to permit the entry of a material track.

The shipways themselves are timber pile and crossbeam construction with one exception. The ways have been divided for ease and rapidity of construction into five contracts, and five separate contractors are at work driving the piles for the ways. One of these contractors, the Raymond Concrete Pile Co., has made arrangements with the Government whereby it is building its ways of reinforced concrete above high tide.

An interesting feature of this yard is the shipbuilders' school. At the upper end of the site is an

inclosure, in which are to be built full-sized parts of a fabricated steel ship merely as instruction work for future shipbuilders. Recruits at this school are paid 30c. an hour while learning the details of ship erection, and are put through an intensive six-weeks course before being turned over to the real shipbuilding work as qualified workmen.

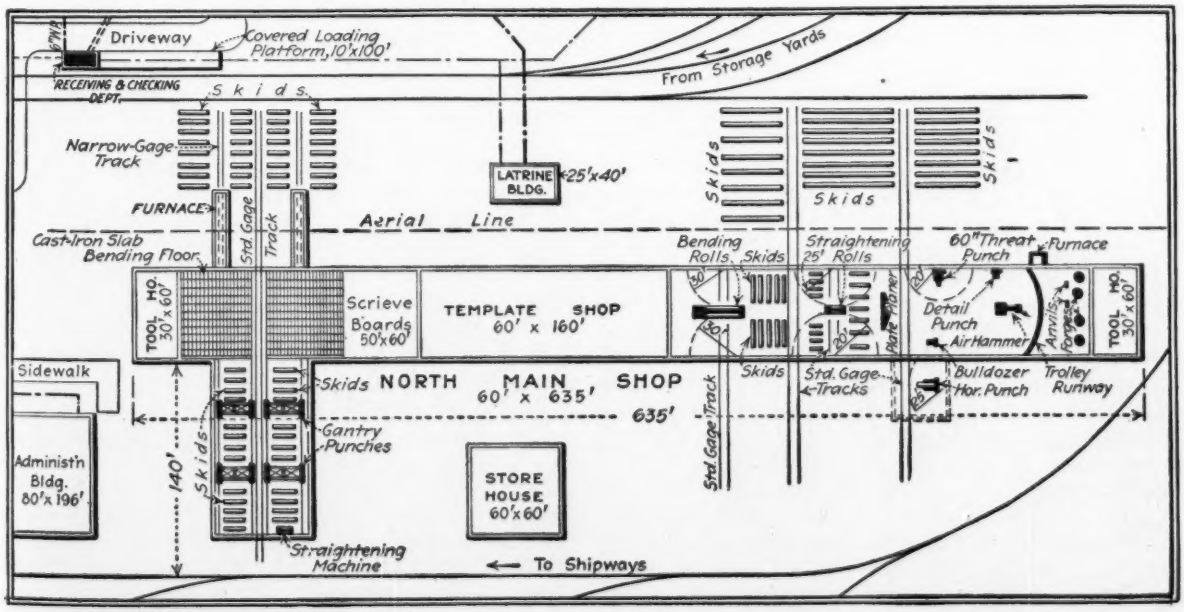
Submarine Boat Corporation, Newark, N. J.

THE shipyard of the Submarine Boat Corporation occupies about 125 acres at the southerly end of the new Port of Newark Terminal. This terminal, a municipal project of the city of Newark, N. J., has been under construction for a few years past. It comprised when taken over for shipbuilding last August a flat sand fill some five feet above high water in Newark Bay, with a parallel frontage of about 2700 ft. on the bay, where the depth of water at present is 12 ft., and extending back about 1800 ft., with a channel on one side. The main channel in the bay has a depth of 25 ft., and the Government is now engaged in dredging to that depth to the approaches to the yard, with 12 ft. depth up to the bulkhead. This site is about four miles from the City Hall of Newark, about a mile from the main line of the Central R.R. of New Jersey, and a mile and a half from the lines of the Lehigh Valley and Pennsylvania railroads. It is also entered by a municipal railroad, known as the Port Newark Terminal R.R., which connects with the various adjacent trunk lines. There is no approach at present by electric car, but the local transportation company is engaged in laying track so as to reach the entrance to the yard. The whole area has city sewer and water connections, and is laid out in cobblestone streets, some of which are in such location as to be available for the present purpose. A bulkhead dock-wall exists alongside the property. In this yard will be built, according to present plans, one hundred and fifty 5000-ton boats.

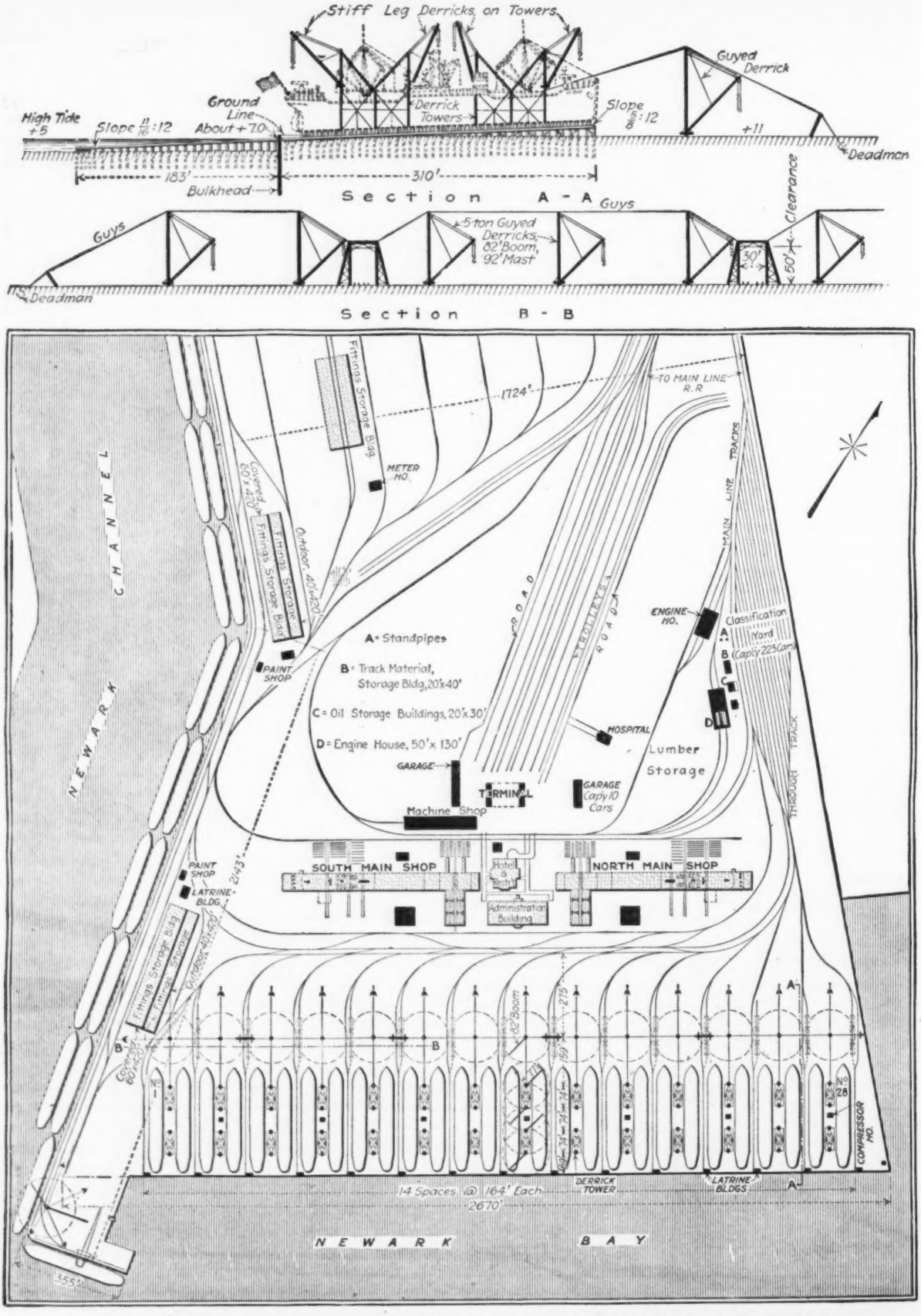
The accompanying drawings illustrate the layout of the shipyard and the proposed method of routing materials through the yard. The railway entrance is from the extreme northerly corner of the site. Here the tracks divide into three groups, the easterly leading to a classification ladder, the middle to a group of passenger tracks and the westerly to the fitting-out dock and a large storage yard. Most of the fabricated material ordered from outside shops enters on the northern corner of the yard through a classification ladder running along the east property line. Here the material is separated and delivered by rail to each of the 28 identical ways as required. At the south side of the classification ladder are through tracks leading to the shop in the central portion of the site. On these tracks will enter the ship steel which is to be fabricated in the shops for the bows and sterns of the vessels. Further to the south lies the lumber storage yard in which the mill-cut timber will be delivered and stored, and which is entered by a single track for delivery. Most of the material from this yard will be delivered to the ships by rail. Between the lumber-storage yard and the ladder are the necessary railroad structures, such as the engine house, oil-storage building, track-material storage, standpipes, yard master's office, etc.

At the south of the freight tracks are six passenger tracks leading to a passenger terminal at the entrance of the shop. These six tracks have gantleted platforms each 12 ft. wide and 640 ft. long, and in addition there are three trolley track entrances. So great a passenger terminal is required because virtually all of the 12,000 workmen who, it is expected, will be maintained at the plant, have to come to the plant by train or trolley because housing possibilities on the Newark meadows are virtually nil. There is, as a headhouse to the passenger track, a covered concourse with adjacent waiting room and employment office.

Farther west are the storage tracks, between which will be kept all fabricated material which cannot be



NORTH MAIN SHOP LAYOUT IN NEWARK SHIPYARD OF SUBMARINE BOAT CORPORATION



LAYOUT AND SHIPWAY DETAIL OF YARD FOR SUBMARINE BOAT CORPORATION AT PORT NEWARK, N. J.

delivered direct to the shipway space, and the materials for the fitting out dock. At the extreme west is the heavy fitting storage building for material that needs protection.

Arranged around the center of the railway terminal is the shop layout. In the middle is a hotel and restaurant of timber frame, with stucco on metal lath walls. It is 76 x 96 ft. in plan and two stories high. Here will be provided rooms for a limited number of the officials of the company and visitors, and a restaurant for at least the office force. Commissary provisions for the mechanics will be made at various places around the plant. Directly in front of the hotel building is the administration building, 80 x 196 ft. in plan and two stories high, of wood frame structure with stucco walls.

On either side of the administration building are twin shop layouts, known as the north shop and south shop. These shops are identical in construction and size. They are arranged so the ship steel can be delivered from the railway tracks to skids and after fabrication pass out upon tracks from locomotive cranes traveling on the main-line tracks of the yard, which lead to the ships and to the fitting docks. The shops are of light steel frame construction, with corrugated iron walls, execpt in the case of the template shop, which is heated and which has stucco walls similar to those on the adminsitration and hotel buildings.

Ways Controlled by Derricks Between Ways

The shipways are laid, as shown in the drawing, in groups of two, controlled by the main-line tracks running between the two ways of each group. The ways themselves are of timber piles, of which 26,340 are to be used in the 28 ways, driven out about 180 ft. into the water and reaching back 310 ft. upon the land. The piles are capped with horizontal timbers forming the ways. High tide is about 6 ft. below the present grade of ground at the bulkhead line. The bulkhead is cut and the ways are so arranged that high tide hits the way about 50 ft. out shore of the bulkhead line. The ways are controlled in the first place by the tracks mentioned, and by derricks. In front of each pair of ways and between the tracks is a boom derrick of 7½ tons capacity and 82 ft. boom. Between each group of twin ways are two towers ,each carrying two boom derricks of five tons capacity with 77 ft. radius, so that they can reach across the way into the intergroup storage space entered by the material railway. These derricks are stiff-legged and do not require guys. It will be noted that the guys for the forward boom derrick at every sixth way are carried over entering railroad tracks by a steel frame sufficiently high to permit the entrance of a locomotive crane with boom vertical. Thus the whole shipbuilding operation is controlled from the derricks. It is expected that a certain amount of framing will be done within the area of the boom derricks in the open.

When the ship is launched it is to be towed over to the southeasterly corner of the yard, where it will be fitted with the heavy fittings, such as engines, boilers, etc., either from shear legs or a hammer-head crane. The details of this particular part of the operation are not yet complete. The heavy fittings will be brought down from the covered fittings storage buildings which are being built at the southwestern end of the yard, and from the heavy fittings storage building which lies at the north end of the yard. Connections between these shops and the fittings dock are on standard tracks. After the heavy fittings have been made, the ship will be moved along the dock in the south channel and will be completed there. It will be noted that there are covered fittings storage buildings and paint shops available at this part of the yard. There exists room for 16 ships lying two abreast along this part of the yard.

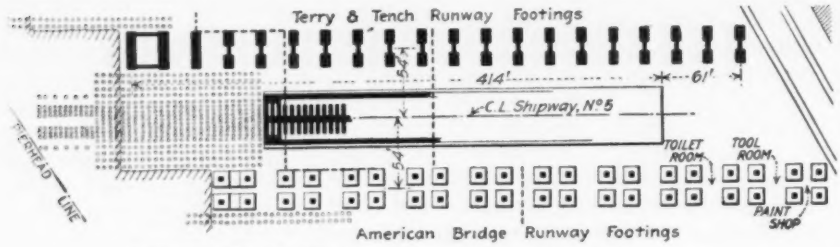
The entire plant is to get its power from local electric power companies, somewhere between 9000 and 13,000 hp. being the estimated power required. There will be a substation built immediately east of the railway terminal, which will take care of the transformation of power for the shops, but the compressor houses and transformer for the shipways will be located in small houses between every fourth set of ways, there being seven such houses to the yard. The main administration building and hotel and the template shop will be heated from their own heating plant. The rest of the buildings will not be heated. As noted before, the whole area has water mains and sewers put in by the company from city connections and latrines are scattered all over the yard area, as shown in some of the drawing details. There will, in addition, be a hospital near the railway entrance.

The construction work is being done by the Submarine Boat Corporation which for this work has a close affiliation with the Lackawanna Bridge Company.

Merchants Shipbuilding Corporation at Bristol, Penn.

THE third of the agency plants, now being built by the Merchants Shipbuilding Corporation at Bristol, Penn., is the smallest of the three Government yards, and in many ways it is the most nearly complete. It is on the Delaware River about 23 miles above Philadelphia, and adjoining the city of Bristol. It occupies about 265 acres of flat land situated between the river and the main line tracks of the Pennsylvania R.R., an area which had been partly covered with the plant of the Standard Cast-Iron Pipe and Foundry Co. This plant was bought by the shipbuilding company early last summer, and certain of its buildings are being utilized for the new shipyard.

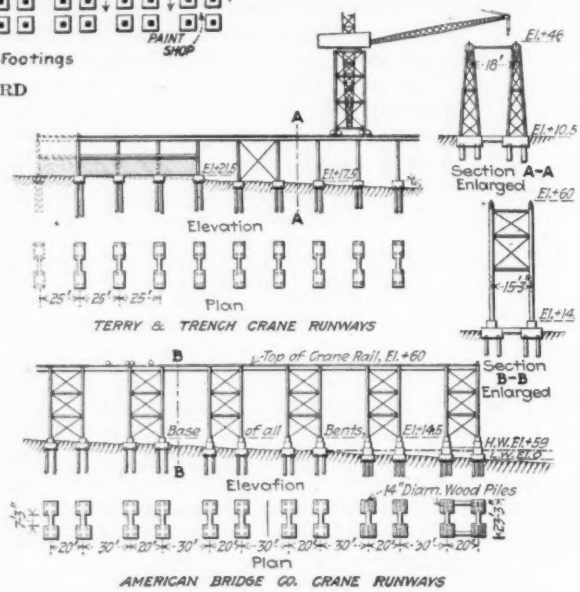
The general layout of the plant is shown on an accompanying drawing. The shipyard proper extends along about 3600 ft. of river front and back about 1500 ft. from the river. It is divided into four yards, numbered 1 to 4, and containing the various service buildings, the sorting and storage spaces and the shipways themselves. The industrial town which is being built to house a large number of the employees in the plant lies between the plant and the railroad. Twelve ways are provided in which can be built simultaneously twelve ships up to a length of nearly 500 ft. The 40 fabricated ships assigned to the company have a deadweight tonnage of 9000 tons each. Provision is made for the simultaneous fitting out of three ships at the wharf downstream from the ways.



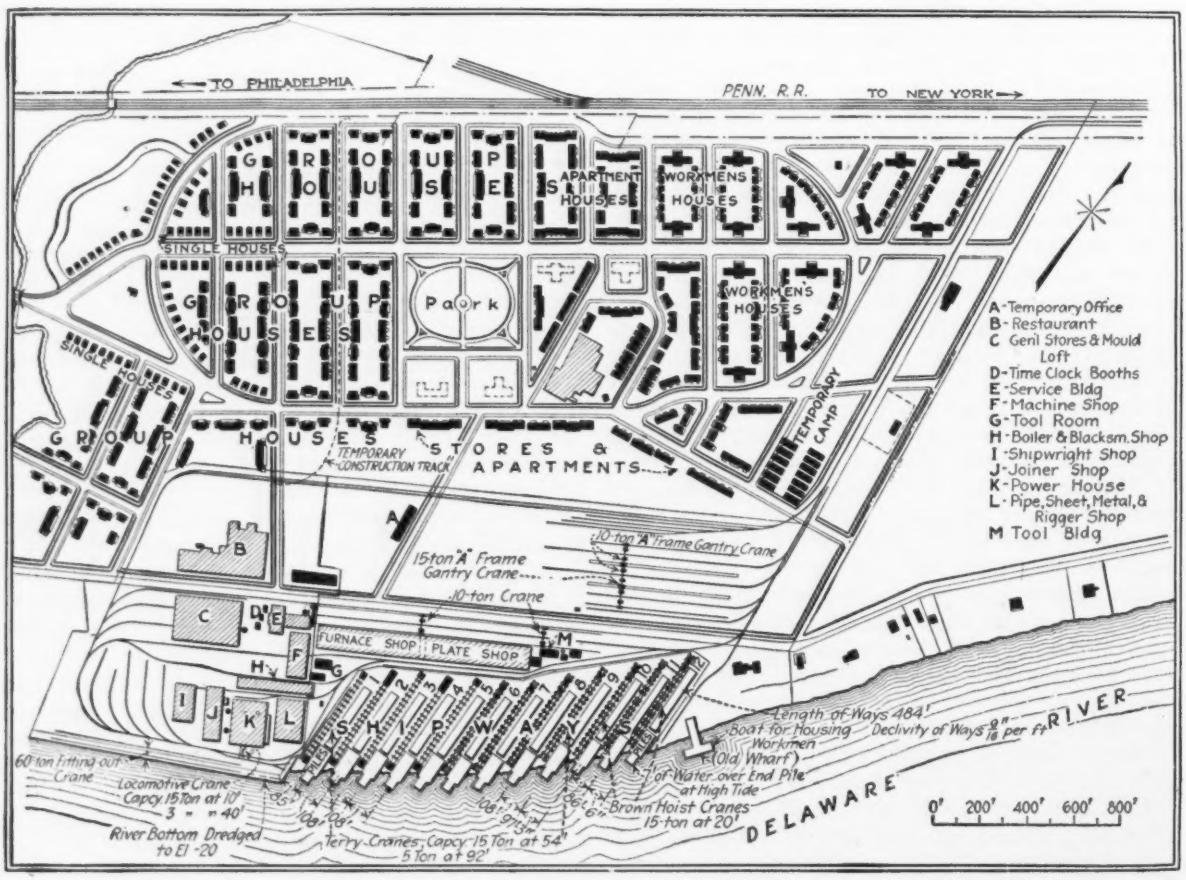
DETAIL OF ONE SET OF WAYS AT BRISTOL YARD

Material will enter the yard from the extreme north end of the site of a single track line switching off from the main line of the railway, or from another single track line running through the town site to Yard 4 at the lower end of the plant. The former line leads first to a six-track ladder for temporary unloading to the yard area labeled Yard 1. Here will be stored most of the lumber which will be taken to the plant by motor truck. Continuing through this first ladder are two tracks leading to the fabricating plant at the south end of the yard. Just beyond the first ladder is located the main structural yard. Here are four tracks controlled by two 10-ton and one 15-ton A-frame gantry cranes, and in this space will be stored the incoming fabricated steel from outside shops. From this yard this material will be distributed as needed to the main-line entrance tracks and sent to the railroad track which runs parallel to the river at the shore end of the shipway. All of the yards and track noted heretofore are outside of the main fence line of the yard.

Nearer the river are two tracks, leading from the entrance track, which run on either side of the main plate



TWO TYPES OF CRANE RUNWAY AT BRISTOL



SHIPYARD AND INDUSTRIAL TOWN AT BRISTOL, PENN., FOR MERCHANTS SHIPBUILDING CORPORATION

shop. The track on the shore side of the shop will be used for the main storage of steel which has to go through the plate shop, and will be controlled by two 10-ton gantry cranes, as shown. The track on the river side of the shop runs into branches which control the general fabricating yard and lead to the storage ladder shown at the south end of the site. These ladders, as noted before, are also connected by a back track through to the shore end of the site.

At the southwest end of the site are located the fiting-out shops all of which are utilized in the production of material for fitting out the launched ships lying along the fitting-out wharf at the south end of the site. This wharf is controlled by a 60-ton fitting-out crane running on 30-ft. gage tracks immediately alongside the water side of the wharf. In this part of the site, too, will be located the main entrance to the plant with the offices, time-check booth, etc., and just outside of the fence will be a garage and a large restaurant with accommodations for 2650 men.

Some Old Buildings Are Utilized

The buildings in the plant, as noted before, are some of them new and some of them utilization of the old foundry buildings. The main furnace and plate shop, for instance, which is more than 1000 ft. long, is for the most part the old foundry building, with additions to square it out and make it continuous. It is a steel-frame building with brick and corrugated iron sides. The power house is being built around the old power house, which remains in service during the reconstruction. It will be provided with a belt conveyor leading down to coal storage, which is kept filled from cars on tracks running down to the end slip alongside of the fitting-out pier. Coal will be brought in by water. The joiners' shop and shipwright shop alongside the power house are new steel-frame buildings, while the pipe, sheet, metal and rigger shop to the east of the power house is an old building. The boiler and blacksmith shop is an old building with additions. The machine shop is an old building. All the service buildings are new. The general stores and mold loft, a structure 200 x 300 ft. in plan, is a new combination reinforced-concrete and steel structure. The first two stories are of flat-slab reinforced concrete and they carry a third story with steel columns and a steel truss roof to provide a sufficient span for mold loft operation, which cannot be carried on with the close column spacing necessary for concrete construction. A remarkable record was made by the contractor in finishing this building in 45 days from the time it was started.

The shipways are 484 ft. long, spaced 108 ft. on centers for the first nine at the west end of the yard, decreasing to 97 ft. for the tenth and 86½ ft. for the last two ways, respectively. They have wooden piles at the water end, reaching up to high water, at which time there is 7 ft. of water over the end pile. There is about 6 ft. of tide here. From the end of the wooden piles, which are capped with wooden beams and provided with a wooden floor, the way continues up on concrete piles with cross-beams and slabs of reinforced-concrete footing on concrete piles of the Raymond type. The openings between these cross-beams are filled in up to the level of the beams with dirt. This section continues up to a point where the ground has a safe bearing value of two tons per square foot, above which the sloping continues and a 4-ft. concrete slab on the ground itself, or, in cases where the ground permits it, the 4-ft. mattress, is lowered and the surface is brought to grade with cross-beams filled in between with dirt. In a few places, where the grade of the shipways becomes more than 10 ft. above the level of the ground, the upper ends of the ways are carried on reinforced-concrete bents.

The shipways are controlled by crane runways located between each set of shipways and carrying two boom cranes to each runway. These runways are of two types. These southerly five runways are of a type designed by Terry & Tench, and carry Terry & Tench cranes. The seven northerly runways were designed by the American Bridge Co. and carry, for Craneways 6, 7, 8, and 9, Terry & Tench cranes; for Nos. 10, 11, and 12 the American Bridge Co.'s bents carry Brown Hoist cranes.

The Terry & Tench runways consist of triangular towers footing on individual concrete bases on piles, braced across at each bent with a concrete strut. The crane towers are braced across at the top with steel struts and longitudinally with a bracing as shown in the drawing. They carry Terry cranes which have a capacity of 15 tons at 54-ft. boom lengths, and five tons at 92-ft. boom lengths. The American Bridge Co. bents are of the braced square-tower type shown in the drawing and rest on spread footings on piles. These piles are of wood in the below-water sections and of Raymond concrete type above water. The Brown Hoist cranes have a capacity of 16 tons at 54 ft. These cranes will control the entire shipbuilding operations, taking material from the cars on the tracks paralleling the river at the rear of the shipways.

New Town Will House Most of the Workmen

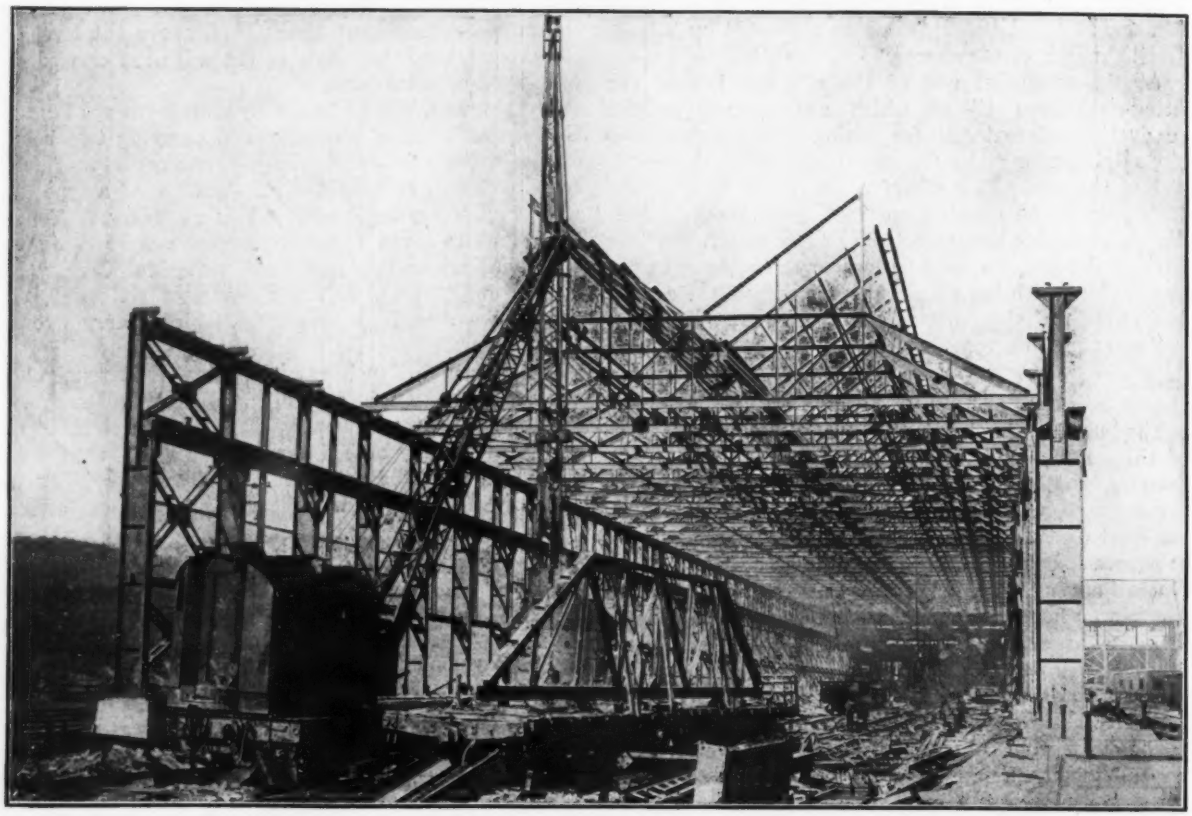
Each crane runway has at its shore end a house for paint rooms, transformer buildings, toilet rooms, tool rooms, etc. Power for the entire work will be generated at the steam power plant, located at the south end of the yard. Here also will be all the compressors, and air will be led throughout the plant through a special pipe line, controlling the shops and shipways.

The industrial town warrants separate description in another article. Briefly described here, it consists of well-planned city blocks comprising groups of bachelor quarters with boarding houses at each end of the blocks, apartment houses for small families, group houses for somewhat larger families, and single houses for such as require or desire them. The buildings are of a series of uniform interior layout, but great attention has been paid to a diversity of architectural treatment so that a pleasing effect is achieved. These buildings will house about 3000 employees. It is hoped that 2000 more will be able to find homes in Bristol or vicinity, about 300 in an old excursion steamer which has been moored at a wharf at the site, and 700 of the lower-grade workmen in camps.

The work is divided into contracts as follows: Housing and plant buildings, Fred T. Ley & Co., Inc.; shipways and water work, John Monks and Sons, and mechanical equipment, William Gordon Corporation.

Build Hundred and Ten Inch Plate Mill in Six Months

Employees and Office Force of Carnegie Steel Company's Homestead Works Supply Construction-Labor Deficiency by Saturday and Sunday Work



LOCOMOTIVE CRANES SETTING ROOF TRUSS ON THE 664-FOOT SHEAR BUILDING

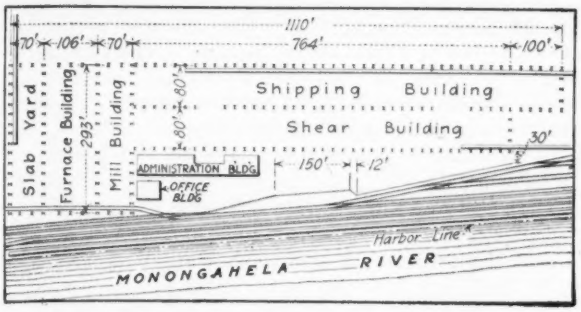
ON APRIL 17 the Homestead Works of the Carnegie Steel Co. received orders to build, on a site covered with 70,000 tons of scrap metal and materials, a 110-in. plate mill with the greatest possible expedition. Ship plates for the country's new merchant fleet were the need of the hour, and plate-mill capacity had to be increased at the earliest possible moment. Therefore it was decided to finish the new project, forthwith christened the "Liberty Mills," with the greatest possible dispatch.

A mill of this size had not been under consideration at the Homestead Steel Works when the order to build was received. There were no spare parts which could be taken from other mills; no engines, no machinery was available. Pencil had never been put to paper in the way of preliminary estimates or designs. The construction was thrown on the hands of men who were already burdened with unusual difficulties at an unprecedented time; men whose minds were occupied with the problems of insufficient coal supply, scarce and inefficient labor, and transportation difficulties. Ordinary labor was virtually unobtainable, and it was actually the first of June before it was possible to clear the site and start construction operations.

Yet the mill was formally opened and began the production of ship plates on Oct. 17, three months ahead of the earliest time that anyone had dared to predict.

After 2400 carloads of scrap metal and miscellaneous material had been removed from the 300 x 1100-ft. site, there remained 71,950 yd. of excavation to be taken out. While 17,147 cu.yd. of concrete and 50,120 cu.yd. of backfill were placed, 40 miles of temporary track had to be laid, changed and removed. The construction of a 5-ft. sewer 1000 ft. long was necessary, and seven mill buildings, with a floor area of 215,000 sq.ft. and with 3390 tons of steel framework, were erected. In addition to this, there had to be manufactured and erected the mill itself, with its 4000-hp. motor, a large number of cranes and much auxiliary equipment. Moreover, it was necessary to enlarge the power house across the river at the Carrie furnaces of the Carnegie Steel Co., to provide for the operation of the new mill, by installing a new gas engine and a 3750-kw. generator. To take this current to the plate mill a 2-mile transmission line, including a 1030-ft. span on a pair of 115-ft. steel towers across the Monongahela River, was constructed.

The most serious construction difficulty was that of finding sufficient common labor. The main sewer trench, for illustration, and much of the footing excavation work, could have been done by hand under other cir-



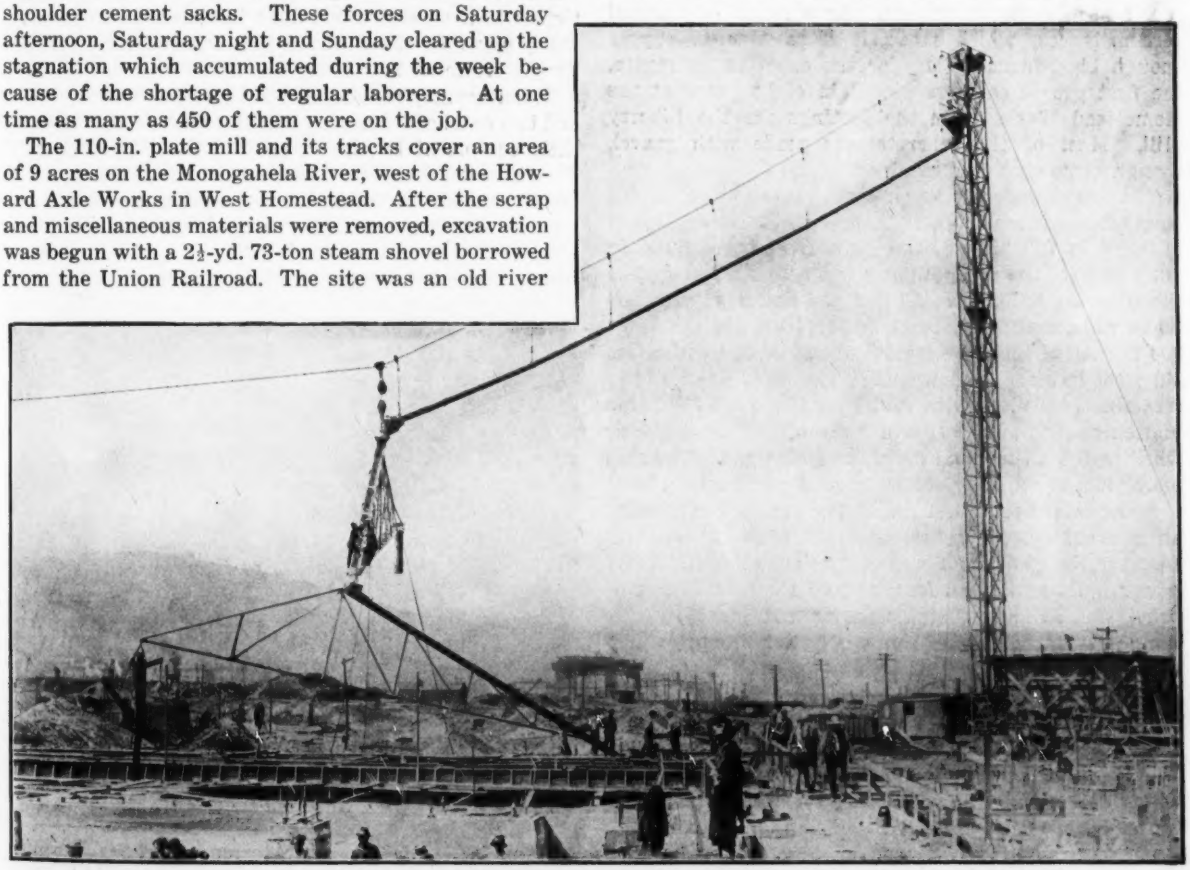
BEFORE WORK COULD BEGIN, 70,000 TONS WERE REMOVED FROM 300 x 1100-FOOT SITE

cumstances. As it was, the most quickly available steam shovels, which happened to be of the railroad type, were set to work, and a trench twice as wide as was needed was excavated for the sewer in far less than half the time that would have been required, under the circumstances, to do the job in the ordinary way. A second shovel, following along behind the laying of the 5-ft. concrete pipe, threw in the backfill, as shown in one of the photographs. All common labor, however, could not be dispensed with, and in the last analysis it was the volunteer labor that saved the day and made possible the early completion of the mill. Officials and clerks from the offices of the Homestead Works and from the general offices in Pittsburgh, as well as skilled mechanics and mill workmen, turned out after their regular hours to wield shovels, push wheelbarrows and shoulder cement sacks. These forces on Saturday afternoon, Saturday night and Sunday cleared up the stagnation which accumulated during the week because of the shortage of regular laborers. At one time as many as 450 of them were on the job.

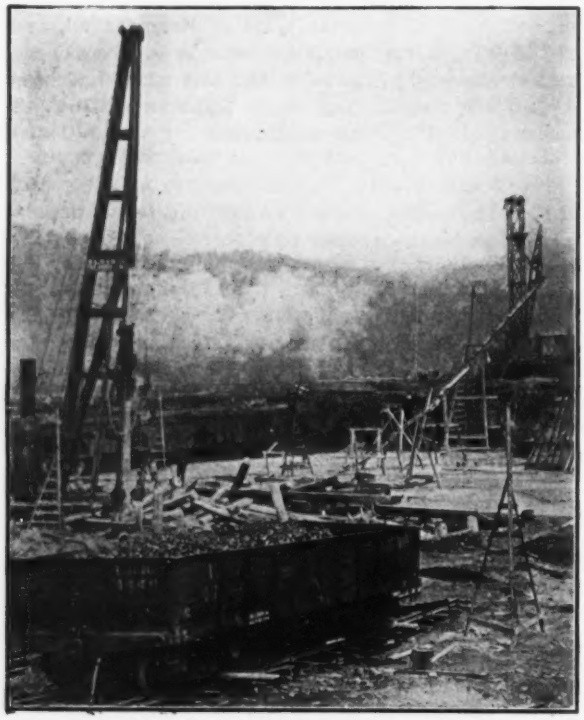
The 110-in. plate mill and its tracks cover an area of 9 acres on the Monogahela River, west of the Howard Axle Works in West Homestead. After the scrap and miscellaneous materials were removed, excavation was begun with a 2½-yd. 73-ton steam shovel borrowed from the Union Railroad. The site was an old river bottom of mixed materials, part of it cinder fill, and most of it of a treacherous character. At the east end the soil consisted of old ashes and dirt which had been in place for a number of years, and which had to be removed. In the main foundation for the mill and mill motor 110 forty-foot concrete piles were required. The west end, however, which consisted of a hot slag fill 10 to 15 ft. deep, afforded an excellent foundation.

The foundations are all of concrete, continuous for the brick buildings, and of the single pier type for the main mill building columns. In ordinary construction individual pits are usually dug for such columns, in which the concrete forms for the piers are built. On account of the scarcity of labor, however, this excavation was done at the Liberty Mill with steam shovels, the 2½-yd. railroad shovel already mentioned, two ¾-yd. and one 1½-yd. shovels each taking a line of column footings and cutting straight through from one end to the other, leaving a long trench in which the forms could be set. The piers were then built and the material backfilled. The same excavation scheme was followed in constructing the 1000-ft. sewer, the 73-ton shovel digging a trench 18 ft. deep and 30 ft. wide for its entire length.

The concrete was mixed in four ½-yd. and four 5-ft. mixers. The 160-ft. steel tower shown in the photograph was used to place the heating furnace and mill-building footings. It was supplemented by a portable tower 45 ft. high mounted on a railroad car. In addition to these two towers, concrete was also placed with



TALL STEEL TOWER WITH COUNTERWEIGHTED CHUTES COVERED LARGE FOOTING AREA



TRACK PLANT PLACED LARGE SHARE OF CONCRETE

a mixer mounted on a flat car, and moved from pier to pier as the work progressed. As a result of unusual circumstances, which made it impossible to supply enough blast-furnace slag for the concrete aggregate, the first gravel concrete placed in eight years at the Homestead Works is in the footings for the Liberty Mill. Most of the concrete was made with gravel, though some slag was obtained.

The mill comprises seven units, in addition to the power-house extension across the river. The slab yard building is 70 x 293 ft., the heating furnaces building 106 x 293 ft., the mill building itself 70 x 293 ft., while the shipping building and the shear buildings are each 80 ft. wide, the former being 864 ft. long, and the latter 764 ft. All of them are steel-frame buildings with glass sides set in steel window sash. The buildings all have straight truss roofs with ventilator louvres. The shear and shipping buildings have roofs of a sawtooth type which gives an unusual amount of daylight. The mill office, 46 x 64 ft., is of semi-fireproof construction.

A departure from the customary practice of placing all the equipment within the mill building itself is found in the addition of a special mill office, comfort and power building 242 ft. long and 40 ft. wide. Built of brick, this building contains the transformers, two air compressors, the pressure pumps, water filters, return-water tank and accumulator, in addition to the physical testing laboratory and machine shop, besides its own heating plant and locker and wash rooms. The separation of machinery from the mill proper has been carried a step further by housing the 4000-hp. motor which drives the mill in its own separate brick building under the main mill roof. This building contains in a separate room the switches, resistance coils and other accessory electrical equipment.

The steel work for the mill buildings was designed by the American Bridge Co., and fabricated in part at the Ambridge plant of that company. The remaining portion was made at the Upper Union Mills fitting shop of the Carnegie Steel Co. The steel for the extension to the power house at the Carrie furnaces, however, was detailed at the Homestead Steel Works, and fabricated in its own shop.

The ability of the Homestead Works to manufacture and fabricate its own steel and to do machine-shop work was a large factor in the rapid construction of the mill. Buildings and machinery were designed and ordered without any rechecking. Drawings came out of the drafting room daily, and the most remarkable part of the engineering side of the work was that absolutely no mistakes were made. Not one piece went out of the shops that had to come back.

The mill buildings were erected by the American Bridge Co. with its own force in the remarkable time of 49 days, the chief erection tool being a locomotive crane with a long goose-neck boom. This work was begun on Aug. 2 and finished Sept. 22.

The plate mill itself, which is the first electrically operated one to be installed by the Carnegie Co., is a three-high mill with 110-in. length of roll body. It was designed by the Homestead Steel Works and built jointly by McIntosh, Hemphill & Co. and the Mesta Machine Co., Pittsburgh. The machining of many of the castings was done by the Homestead Steel Works. The practice on motor-driven mills has always been to use machine-cut pinions, but in this case it was impracticable to have such work done in time. Consequently, the pinions in the Liberty Mill are machine molded. They operate as noiselessly as any cut gears.

Seven cranes, ranging from 10 to 50 tons capacity, and two overhead charging machines were made with all their equipment by the Homestead Steel Works itself. The three main shears, which consist of two side shears and an end shear, were made by the Morgan Engineering Co. In the same way the straightening rolls were

WIDE SEWER TRENCH DUG TO PASS STEAM SHOVEL

made outside by R. S. Newbold & Son Co., but the roll tables were made at the Homestead shop.

The construction of the mill in six months was a feat which could be accomplished only through the closest co-operation between builders and manufacturers of structural steel and machinery. Among many unusual incidents connected with the furnishing of equipment, one may be mentioned. The large casting for the General Electric motor for the main mill was ordered from the Wheeling Mould and Foundry Co., as it could not be delivered by any firm in the East because of prior business. The Wheeling Co. made a new pattern and cast the spider in three weeks. The traffic manager of the Homestead Steel Works delivered this spider and other castings from the Wheeling plant to the General Electric Co. in Schenectady within three days. The shaft for this huge motor, which the General Electric Co. likewise experienced difficulty in securing, was made in record time by the armor plate department of the Carnegie Steel Co. The General Electric Co., by a most extraordinary performance in its own shop, reduced the time of delivery for this motor from eight months to little more than five.

The Liberty Mill rolls plates up to 100 in. wide, and from $\frac{3}{16}$ to 2 in. thick. It rolls from slabs provided from the Homestead Furnaces, the Farrell Steel Works and Furnaces, the Ohio Steel Works and Furnaces, and the Donora Steel Works and Furnaces. Its best production so far is 266 tons in a single turn of 10 hours, with six of the eight furnaces in operation. With an ample supply of steel and orders suitable for maximum production, the mill will be able to roll 16,000 tons of plates per month. Its cost will approximate $2,500,000, including the new gas engine and generating installation at the Carrie furnaces. On double turn it will employ approximately 250 men. It was built under the supervision of A. A. Corey, Jr., general superintendent of the Homestead Steel Works, R. H. Watson, assistant general superintendent, and J. W. McCready, manager of the producing department. These men and the department heads held daily conferences at the site at 7:30 in the morning, and each division of the operating organization had charge of the construction of that portion of the new plant which it now controls in the production of plates. The chief civil engineer, F. B. Schaeffer, was responsible for the grading of the site, laying the foundations, constructing the sewer, doing the underground work, installing the equipment, making the backfill and handling the railway tracks. The design of the mill buildings and the mechanical engineering work were in the hands of A. W. Soderberg, chief mechanical engineer. Charles S. Frye was superintendent of construction, and Kenneth Lean was superintendent of transportation and labor. James Horton, efficiency engineer, acted as special ambassador to the various contracting firms furnishing mill equipment. Each department worked out its own problems in connection with the design and construction.

Acres of Shops To Form Ordnance Base in France

Simple Design Uses Steel Members of Uniform Size with Bolted Connections—Estimated Cost Several Millions

UNIFORMITY in sizes of structural steel members, to permit of interchangeability to a degree unusual in shop erection practice, and extreme simplicity of design, involving the use of bolted instead of riveted connections, are features of the mammoth ordnance base depot which the U. S. Government is building in France for the salvage of used American army equipment, ranging from the repair of haversack buckles to the relining of large caliber siege guns. This vast construction enterprise, upon which Maj.-Gen. William Crozier, Chief of Ordance, and his staff, and Stone & Webster, the contractors, have embarked, will involve an expenditure up in the millions of dollars, according to an authorized statement made to a representative of *Engineering News-Record* in Washington recently, and when completed will require for its operations the services of several thousand men, including machinists, toolmakers, molders, harness makers, electricians, blacksmiths, motor-truck repair men and representatives of scores more of skilled and unskilled trades.

The buildings, which are to serve as shops and warehouses, are of simple steel-frame construction. They are uniformly only one story in height, and are lighted by roof monitors. The group of structures, however, will cover a ground area of something like 100 acres, and will involve the erection of about 18,000 tons of structural steel, all of the latter being shipped from the United States.

Some misconception regarding the American Ordnance Base Depot has been caused by the circulation of a newspaper story to the effect that the work would cost $100,000,000 and that the contractor would receive a 10% profit. The facts, as given to this journal by a member of General Crozier's staff, are that the cost, as noted, will be much less than this sum, and the contractor will work on a sliding scale of 3½ to 3% of the gross, depending upon the total cost.

Function of Plant

Repair of ordnance material will be the chief function of the big plant. In this connection General Crozier made the statement that the newer models of heavy field guns used by the allied armies are showing wearing qualities, under exacting conditions of actual field service, which have far exceeded the expectations of army experts. But even the best of the guns require periodic overhauling, and will be brought to the ordnance base depot for that purpose. Facilities will there be provided for boring out and relining the biggest field and siege guns and howitzers. Gun carriages, with their recoil cylinders and counter recoil springs, will be repaired, and caisson and limbers will be made almost as good as new. There will be shops and equipment, also, for handling repair work on rifles, bayonets, machine guns, pistols, leather accessories and harness, canteens and haversacks. Another big work which the base depot will accomplish will be the overhauling of motor trucks, "tanks" and the tractors which are now being used almost exclusively for the movement of heavy artillery

pieces. Airplanes are about the only machines of modern warfare which will not be received at the huge plant now under construction; they will have separate repair shops at other sites.

There will be subdivisions for reforming cartridge cases, and reloading large and small ammunition. Of course, the operation of a plant on so colossal a scale will mean an additional construction program to provide housing for the working forces.

Factors in Design

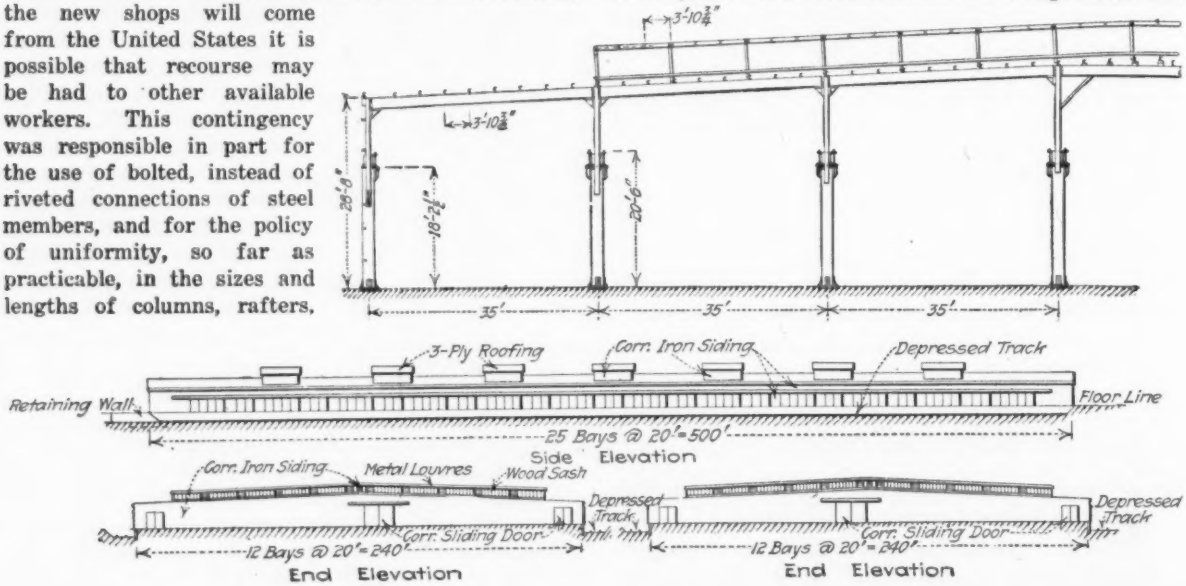
In the design of the shop and warehouse buildings, these factors have to be taken into consideration: All structural steel has to come from the United States; rapid construction progress is essential, and no design involving complicated erection methods can be tolerated. While the bulk of the labor (enlisted men) for building the new shops will come from the United States it is possible that recourse may be had to other available workers. This contingency was responsible in part for the use of bolted, instead of riveted connections of steel members, and for the policy of uniformity, so far as practicable, in the sizes and lengths of columns, rafters, purlins, etc. Keeping in mind the great demand upon transatlantic shipping at the present time, the designers had to select for their shops the lightest steel sections consistent with a reasonable factor of safety.

The whole plant is, in reality, a vast checkerboard of 20 x 35-ft. units. In the case of warehouses and light repair shops any column can be placed upon any footing, or any beam or rafter on any pair of supports, with no chance of error in sizes, as these sizes have been standardized. Of course, there are instances in the machine shops where heavy crane loads call for increased column strength, but the prime idea in the layout was to make the erection of the steel-frame structures as nearly "foolproof" as possible.

This policy of uniformity manifests itself not only in the fact that all bays are 20 x 35 ft., but also in the fact that all columns are of one length, notwithstanding that the roofs of the shops are built at a slope of about ¾ in. per foot toward the eaves. Where the distance between the roof and the ground is shorter than the standard column length, the concrete footing for the column is depressed the required distance.

The sides of the warehouses will be of galvanized corrugated steel, while those of the gun shop will be of asbestos protected metal. The roof design calls for corrugated steel covered by a thin coating of concrete—just enough to cover the ridges and fill the depressions. On top of this concrete layer there will be a covering of three-play built-up roofing. The warehouse floors will be of dirt, except for concrete aisles, while the shop floors will be 6-in. slabs of concrete. As a general rule, the height from floor to roof is 17 ft. at the center, and 12 ft. 6 in. at the eaves.

Some idea of the size of the plant is conveyed by the dimensions of only a few of the buildings; there will, for example, be two gun shops, each 620 ft. long and 245 ft. wide. The truck repair shop will measure 620 ft. long and 610 ft. wide. The various other departments of the plant will be housed on the same large scale. One of the machine shops will contain 79 thirty-in. boring lathes, 102 thirty-eight-in. lathes and 28 forty-eight-in. lathes. These machines, with bed lengths 30 to 60 ft. long, will be used for boring out the big guns. The equipment also includes engine lathes for starting bores and grinders for finishing the gun liners. The grinders alone will involve an expenditure of about half a million dollars.



PART SECTION AND ELEVATIONS OF ORDNANCE BASE BUILDINGS—SIMPLICITY OF DESIGN A CHARACTERISTIC FEATURE

Power for operating the plant will be supplied from existing plants in France. The boring lathes will be run by direct-current motors, and other equipment by alternating current.

In addition to the steel, the United States will supply virtually all of the construction plant needed for the American Ordnance Base Depot, but French cement and local sand and stone will be used for the column footings and other mass concrete work.

The Washington office of the American Ordnance Base Depot is in charge of Col. D. M. King, acting as representative of General Crozier, while the work of the Stone & Webster organization is being directed by John R. Lotz.

Supply Organization Expands 2250 Per Cent To Equip Engineer Troops

More Than Fifty Regiments Are To Be Outfitted—Work Involves the Specification, Design and Purchase of a Large Variety of Engineering Equipment—Speed a Prime Requisite

By E. J. Mehren
Editor "Engineering News-Record"

INCREASING its purchasing activities 2250% within three months; undertaking the equipping in a half year of more than 50 engineer regiments, when only three had been equipped before; building the necessary organization for handling these increased duties, and doing everything at top speed and in a business-like manner have constituted one of the tasks which the war has thrust upon the Corps of Engineers of the United States Army. Specifically, the duties enumerated fall directly to the General Engineer Depot, under the general direction of Major-General William M. Black, Chief of Engineers, and his assistants, Brigadier-Generals F. V. Abbot and E. Eveleth Winslow.

The name, General Engineer Depot, while conveying a correct impression to the army man, does not give to a civilian an adequate conception of the functions of the organization. Its duty is to design, specify, purchase, gather into depots and forward all engineering materials, equipment and supplies for the army—for the equipment of engineer troops and for all other branches of the service, and for all engineering operations in the field. Included are such items as bridges, pontons, rails, ties, rolling stock, grading, excavating and quarrying machinery, hoisting equipment, buildings, portable machine shops, small tools, such as picks and shovels, and the thousand and one items of engineering equipment which modern warfare requires within the theatre of operations.

Pre-War Activities

A consideration of the conditions obtaining previous to April, 1917, is necessary if the magnitude of what has been accomplished is to be appreciated. Even if the work in hand were the normal procedure, it would deserve a leading place in a citation of engineering and commercial activities. The performance is all the more noteworthy when the rapidity of accomplishment and the previous small purchases are taken into consideration.

There are not many businesses in the world in which purchasing averages more than $1,000,000 a day for every day in the year—and probably none in which such a purchasing volume is concentrated in one office. On the Panama Canal, the purchasing of engineering materials and equipment in a 10-year period totaled $175,000,000—a large sum. But, when comparing it with the work of the General Engineer Depot, one must say "only $175,000,000"; for the depot in four months, July 1 to Oct. 31, placed orders aggregating $160,000,000 in value, and this is only a beginning. The expenditure for the fiscal year ending June 30 next will probably total $375,000,000, and if the war should continue, probably double that amount will be spent during the succeeding fiscal year.

In the piping times of peace the mobile army expenditures of the General Engineer Depot were, even for peace times, relatively small. The expenditures for the fiscal year of 1915-16 were $88,000; and for the year 1916-17 $1,317,000. From this relatively conservative sum the rate of expenditure has jumped, as previously related, 2250%. This rate, at present expectations, will not be maintained for the entire fiscal year. While the rate based on the actual commitments of the last four months is $450,000,000 per annum, the actual expenditure will probably approximate $375,000,000.

Troops

Similar impressions of the magnitude of the task are secured by making a comparison between the personnel to be equipped in peace times and now. In 1915 there were only about 1200 engineer troops. In 1916 authority was given by Congress for the organization of seven regiments dismounted and two battalions mounted. This amounted to about 8000 men, who were to be organized in increments during a period of five years. In March of this year, three of the dismounted regiments and one mounted battalion had been organized and were in service. In other words, the maximum call on the General Engineer Depot until April of this year had been for the equipment of three regiments and one battalion, amounting to about 3500 men, plus the engineering equipment normally needed by other branches of our relatively small standing army.

Compared with this past demand, what are the requirements now? Instead of three regiments and one battalion, more than 50 regiments must be equipped—roughly an increased demand of 1660%. There are organized at present the equivalent of 40 divisions, including the Regular Army, National Guard and National Army. Each of these will have a pioneer regiment. The remaining engineer units are specialized, and their equipment is far more complex than that of the pioneers. Of specialized engineering regiments, the following have been authorized:

- Water-supply
- Highway
- Light railroad
- Standard-gage railroad
- Gas and flame
- Forestry
- Mining
- Quarrying
- General construction
- Engineers' supply (base shop and supplies)
- Surveying and printing (one battalion)
- Army ponton park

In some cases these specialized regiments are duplicated, so as to provide them for each army and also for the line of communications.

Service troops are provided for each special engineer regiment. These service troops may be shifted from one special regiment to another whenever necessary.

Moreover, this involves a heavier demand than the figures by themselves show. The equipment for pioneer troops had to a large extent been standardized, though

the advances in modern warfare required the development of special equipment to fit present needs. Even for the 40 pioneer regiments, therefore, the demands per regiment were more severe than for the equipment of the same units in the previous peace régime.

For the special regiments all of the equipment had to be selected, readapted or designed anew. These regiments were authorized in order to meet the developments in warfare made during the present conflict, or to meet special conditions obtaining in the theaters where the troops are to operate. The task of the depot has, therefore, been much larger than if all of the engineer units now consisted of pioneer troops.

The selection of all railway equipment and the negotiations as to prices, deliveries and awards leading up to the actual purchase are handled by the office of the Director General of Railways, under the Chief of Engineers. The orders for this class of purchases are issued by the General Engineer Depot, which also makes all the disbursements in payment.

Work of the Depot

Some idea of the variety of purchasing may be gained from the standard detail supplies of the pioneer regiments alone. These cover more than 300 items. They range all the way from pencils to wagons. It must be remembered, too, that these are the engineer regiments having the least equipment.

As an instance both of the magnitude of contracts and of the speed with which deliveries are being obtained, the following will serve as a typical example: There were demanded for use abroad 100 steel-frame warehouses, with galvanized corrugated iron sides and roof, each 50 ft. wide, 400 ft. long and 16 ft. high to the bottom of trusses. The order for these came to the depot on a Thursday at four o'clock. By Saturday at four o'clock the entire job had been designed and the order placed with seven different fabricating shops. Each building, complete, required 175 tons of steel, and the orders included not merely the structural steel frame and the siding and roofing, but also the windows and doors, and, in some cases, the floors.

It is worth noting here that 75 of the buildings were ordered for delivery in six weeks, and the remaining 25 at a slower rate. In other words, demands as to delivery are adjusted with the purpose of distributing the load on the manufacturers as much as the military exigencies will allow.

Another large-size building contract let by the depot called for 2000 wooden buildings for shipment abroad. These ranged in size from 20 x 25 to 20 x 100 ft., and would, if used for that purpose, provide for the housing of 40,000 men. Fortunately, the depot has in its force an architect with broad experience in both portable and permanent housing for workmen. He quickly modified a standard commercial design to meet the conditions presented. The lumber is being cut and manufactured into panels here; these panels are designed so that they may be assembled into houses by inexperienced troops.

Another large order in the same general class as the preceding called for 750,000 sheets of corrugated galvanized iron to be shipped as quickly as possible. This was supplemented by a standing order for 150,000 sheets per month.

A locomotive order, likewise, gives a good conception of the magnitude of the depot's operations and of the results that are being secured in the matter of delivery. The first order for a certain type of standard-gage, 90-ton locomotive called for 300 units, and was placed on July 19. On Aug. 11, the first engine was delivered, and the order called for completion Oct. 1. The initial order has since been followed by other orders for 680 locomotives of the same type.

In the line of electrical equipment, there have already been purchased 700 1-kw. to 25-kw. gas-electric sets for illumination purposes and for driving small motors. Much special adaptation of existing electrical equipment has been necessary.

Another interesting line of special equipment was called for in an order for portable machine and woodworking shops. The equipment for these is mounted on motor trucks, the power for the machinery being taken from a special generating set.

Machinery and equipment for building and maintaining hundreds of units of highways in the war zone has had to be selected to meet the conditions "over there." All of this plant has been chosen from standard commercial designs or slightly modified standard types.

Classification of Purchases

Viewing the purchases so far made, and excepting the well-standardized part of the equipment of pioneer troops, it is possible to classify them roughly into three classes:

1. Such equipment as is standardized commercially and which, without change, can be used in military service.

2. Such standard commercial equipment as can, by slight changes, be adapted for military use.

3. Equipment not used for commercial purposes, and which must be designed from the ground up.

The policy of the depot is to buy commercial equipment whenever possible. The practice is to view all commercial apparatus available for a particular use and to select that which, all factors considered, is most suitable. General engineering standards apply. Some details, however, require modification for military reasons. The transportation of fuel, the visibility of equipment, the noise of operation, the character of trench conditions, all have come in to cause the rejection or modification of equipment quite satisfactory under normal conditions. Necessarily, therefore, the engineers of the depot having civilian experience in highly specialized lines must be constantly checked by their military associates.

One noteworthy case has arisen in which the work of the depot has clearly disclosed the lack of a standard satisfactory even for commercial use—the rating of gasoline engines. It was found that ratings did not mean the same thing to two different manufacturers. Moreover, almost without exception, the quoted rating was too high. The result has been that all engines are being bought after actual tests have determined their capacities. This is but one instance of the engineering character of the buying the depot is doing.

With reference to equipment that can be used after slight changes have been made, there have been equally interesting experiences. In these cases it is the practice of the depot to ask the manufacturers to send their engineers to Washington in order that the modifications

may be fully discussed and, when possible, decided upon immediately. In that way quick action has been insured —an important factor where speed is an element at every step.

Conferences with Manufacturers

To expedite its work the practice of the depot has been to confer with officials of manufacturing companies from whom it is proposed to purchase, the object being to negotiate with those who have the power to make decisions. The orders are for large quantities. They fully justify the personal attention of the president or some other executive officer of the manufacturing companies. The latter, accordingly, are allowing their chief executive officers to take care of the negotiations. "Brass tack" information is insisted upon, not only with reference to details of design, but also as to delivery. For that reason manufacturers have found it advantageous to bring with them their engineers and shop superintendents. Frequently product and bids have been satisfactory, but deliveries were not. Discussion with the shop superintendents invariably disclosed ways and means by which the production could be considerably increased and the depot's demands met.

A shovel manufacturer, for example, bid upon the production of 7000 shovels in a given time. After going over the matter with the depot and his superintendent, he agreed that he could produce 24,000 in the same interval. A hoisting-engine manufacturer believed that it would be possible for him to handle a proposed order only on the condition that delivery begin in five months and be completed in 14 months. After conference with officers of the depot and the officials of his own company, he proposed to start delivery at once and to complete the entire order in nine weeks. One manufacturer of narrow-gage track was producing before the war half a mile of track per day. Now his daily production is sixteen times that amount.

In the matter of inspection and payment, the depot's work has been most business-like, contrasting favorably with the usual peace-time delays in government procedure. More than 1400 inspectors are either in the direct service of the depot or are at command, much of the inspection being handled by R. W. Hunt & Co. These inspectors are so located that immediate service can be given to any contractor, and the inspectors not only pass on the material, but accept it. They deliver to the contractor a certificate of inspection which the latter sends to the General Engineer Depot with his invoice. Payment is made immediately. Of course the depot gets a Government bill-of-lading, which secures prompt car service and expedites the shipment. Expedition in payment has been secured by having the depot draw its own checks upon reserves set aside for it by the Treasury Department. In this way manufacturers who negotiate heavy bills of material and have big labor bills are enabled to meet their obligations with promptness, a very material factor in securing satisfactory bids.

Organization

When war was declared the General Engineer Depot had 25 people, five of them technical men. Two of the technical men were members of the Corps of Engineers and three civilians. On Dec. 1 the total force of the depot consisted of no less than 621, of whom 96 were engineer officers, five of them members of the Corps of Engineers, and the balance reserve officers. The form of organization is shown on the accompanying chart.

As is evidently necessary, the depot organization has been built up of specialists qualified along the particular lines in which the development and purchasing of the depot lie. As stated in the first paragraph of this article, all of the work comes under the direction of Generals Black, Abbot and Winslow. All three are men of long experience in the work of the Corps of Engineers, U. S. A., having served with engineer troops in the Spanish War, and at various points within the United States. They are, therefore, thoroughly familiar with the needs of troops in the field, and also with the details of the various items of engineering equipment required.

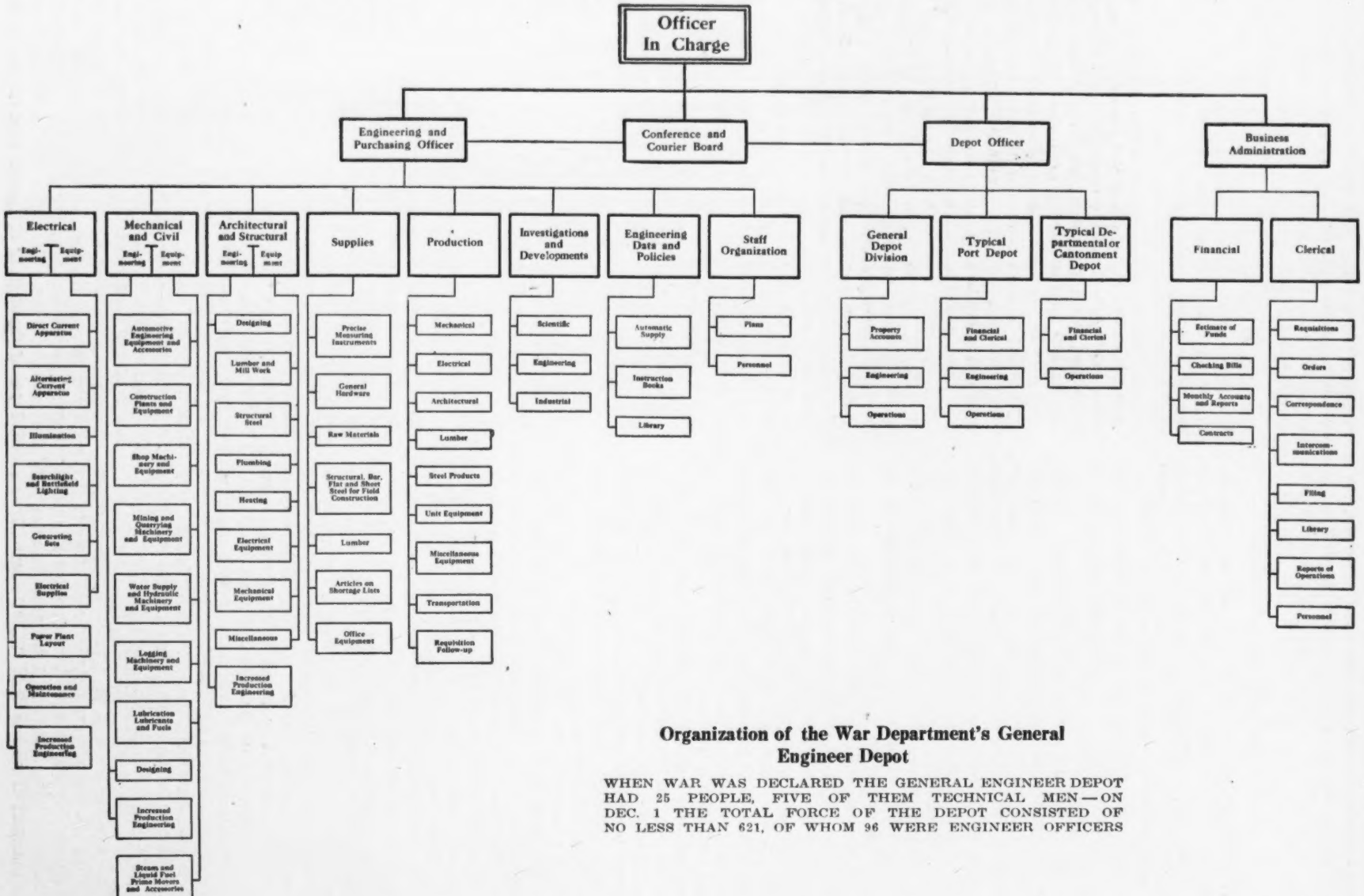
The work of the depot is under the direct charge of Lieut.-Col. W. H. Rose, Corps of Engineers, U. S. Army. His position on the chart is designated by the box labeled, "Officer in Charge." Like his immediate superiors in the corps, he has had a broad experience in the work of that organization, his service, in addition to that in the Philippine Islands and in Cuba, including the position of electrical engineer of the Panama Canal. In the latter capacity he was in responsible charge of all electrical design, construction, operation and maintenance for the canal, his connection having been severed only in June of this year. His canal experience has been directly along the lines of that in the depot, developing, specifying and purchasing in large quantities engineering equipment of great variety, and specializing on electrical apparatus and equipment allied thereto.

Engineering and Purchasing Section

As the diagram indicates, the largest section of the depot's work is that comprised under the engineering and purchasing officer. This important post is filled by Major R. S. A. Dougherty, Corps of Engineers, U. S. A., an officer who, prior to the regular course at the Military Academy, studied engineering at Leland Stanford, Jr., University and at the University of California. After graduating from the Academy he received a degree in special electrical engineering courses at Cornell University. Major Dougherty was selected for this important post on account of his extended experience in handling purchases for large Government contracts.

Each of the principal departments under Major Dougherty is in charge of a specialist. Capt. Lorimer D. Miller, Engineer Reserve Corps, an electrical engineering graduate of Cornell University and for a number of years electrical engineer of the Corps of Engineers, having charge of the design and purchase of military electrical equipment, heads the Electrical Division. During this time he specialized on Coast Defense problems, involving practically all kinds of electrical equipment, apparatus and supplies.

Major Oliver B. Zimmerman, U. S. R., a mechanical engineering graduate of the University of Wisconsin, for many years advisory engineer on sales and manufacturing for the International Harvester Co., and in charge of the development and experimental work of its European factories, is head of the mechanical and civil engineering division. Major Zimmerman has a thorough knowledge of industrial conditions in various European countries. He is particularly familiar with the types of engineering equipment used in these coun-



Organization of the War Department's General Engineer Depot

WHEN WAR WAS DECLARED THE GENERAL ENGINEER DEPOT HAD 25 PEOPLE, FIVE OF THEM TECHNICAL MEN — ON DEC. 1 THE TOTAL FORCE OF THE DEPOT CONSISTED OF NO LESS THAN 621, OF WHOM 96 WERE ENGINEER OFFICERS

tries and with the factors which control the design and selection of equipment for the use of American troops abroad.

Architectural and structural work is under Perry R. MacNeille, a well-known New York architect, who has specialized on industrial housing and whose services have been invaluable in connection which the building work of the depot.

Production is in charge of Earl Wheeler, a graduate of the University of Kansas, who for six years was director of the department of electrical and mechanical engineering at the Engineers' School, Washington Barracks, and subsequently Washington manager of the General Electric Company.

The work of receiving and storing the material, equipment and supplies and of making issues to the various organizations in the United States and shipments to our overseas forces, and of keeping the necessary records and data for property accounting is assigned to the Depot Department.

Two Main Engineer Depots

Two main Engineer Depots have been established, and storehouses, open storage yards, wharves and piers, railroad track facilities and other necessary utilities for receiving, storing and forwarding supplies are under construction and nearing completion. Arrangements have been made for handling shipments through various other ports along the Atlantic and Gulf Coasts.

The principal depots are in charge of Lieut.-Col. Thomas M. Robins, Corps of Engineers, Lieut.-Col. Gilbert E. Humphrey, Corps of Engineers, and Capt. C. W. Markham, Engineer Reserve Corps.

Major John S. Butler, Engineer Reserve Corps, is in charge of the Depot Department in the main offices of the General Engineer Depot in Washington. His principal office assistant is Harry E. Ruckert, depot accountant. Major Butler has for a number of years been an assistant engineer in the United States Engineer Department in charge of important river improvement work. Mr. Ruckert, formerly chief property clerk of the Atlantic Division of the Isthmian Canal Commission, is an expert property accountant of many years' experience.

Financial and Clerical Divisions

The Financial Division of the General Engineer Depot, which handles the disbursements and money accounts, is in charge of Capt. B. H. Namm, Engineer Reserve Corps, and the preparation and administration of contracts is in charge of Capt. C. A. Duff, Quartermasters Reserve Corps, who has been detailed for duty with the Engineer Depot by request of the Chief of Engineers.

The Clerical Division is in charge of W. M. Williamson, chief clerk, who has had many years' clerical experience in the Engineer Department of the Army.

It will thus be seen that the depot has gathered to itself men especially qualified in lines within which the depot's duties fall. This specialized talent, needless to say, has been of exceptional value in advancing the work and securing the results mentioned in this article. These results insure the engineer troops of the army the prompt delivery of the proper equipment.

First Water-Power Electric-Light Plant Nearly Gone

RUINS of the first commercial incandescent electric light plant driven by water-power in this country are shown in the cut herewith. The picture was taken recently by H. G. D. Nutting at Appleton, Wis. It shows the steel shells of the old vertical water wheels installed in 1882 now broken to pieces and lying on the ground. The wood construction is all that is left of the

NOT MUCH LEFT OF THIS WATER-POWER PLANT

harness and support. On the other side of the little bridge are the needles holding the water back in the flume, which is still connected with Fox River, which originally supplied the power.

Many writers in electrical and hydro-electric literature refer to the plant. While it is often mentioned as the first lighting station in the world, recent researches by W. E. Keily, of Chicago, indicate that it is the third, the Holborn viaduct plant in London and the historic Pearl Street station in New York both having been started earlier than the Appleton plant, in the same year.

Chicago Proposes Double-Deck Street

Conversion of a dilapidated and congested market district in the heart of Chicago by removing the old buildings between South Water St. and the river, and forming a broad street along the south bank, is a bold project recently approved by the Chicago Plan Commission. The present narrow street is the center of a produce and poultry market district which causes serious interference with traffic on main streets intersecting it, and several propositions have been made for the removal of this business to some other section of the city, where better facilities could be provided.

The proposed improvement would provide a 110-ft. river-front street extending for about eight blocks, from Michigan Ave. to Lake and Market Sts. This would be at the level of the bridge roadways, and reserved for light traffic. Beneath would be a space 135 ft. wide, open on the river side, utilized for a roadway for heavy teaming, a double-track line for through-route street cars, a public parking space for automobiles, and freight terminals served by carfloats and lighters. The cost is estimated at $5,282,680, of which $3,700,000 is for land and buildings at $31.22 per square foot.

Drive 15,000 Piles for Pair of Thousand-Foot Shipways

Using Machines with Two-Way Motion Rolling on Finished Rows—Cofferdam Incloses Outboard Ends—Dredge and Travelers Do Excavating

A PAIR of shipways on which the largest naval vessels can be constructed have been completed, so far as driving the 15,358 piles in them is concerned, since May 2. Four drivers, each built to roll crosswise on a trussed frame which travels lengthwise of its work on a track laid on piles already driven, have proved valuable. The upper ends of the shipways are above ground, but the lower ends require much excavation, which was done in the water by a floating dredge, and finished, after a cofferdam had been built around the outboard ends, by traveler derricks with grab-buckets.

One of the shipways is 1000 ft. in length, and one 850 ft., the former having an outboard length of 87½ ft. and reaching a depth of 14 ft. at high tide, while the latter has an outboard length of 130 ft. and reaches 16 ft. at high tide. The shipway which extends furthest up the shore has 8192 wood piles averaging 40 ft. in length, while the other contains 7166 piles. These piles, which reach hardpan at an elevation 40 ft. below mean low water, are designed to carry a load of 20 tons apiece. This necessitates their being spaced on 2-ft. centers in both directions underneath the bilge, this spacing being increased to 7-ft. centers at the outside.

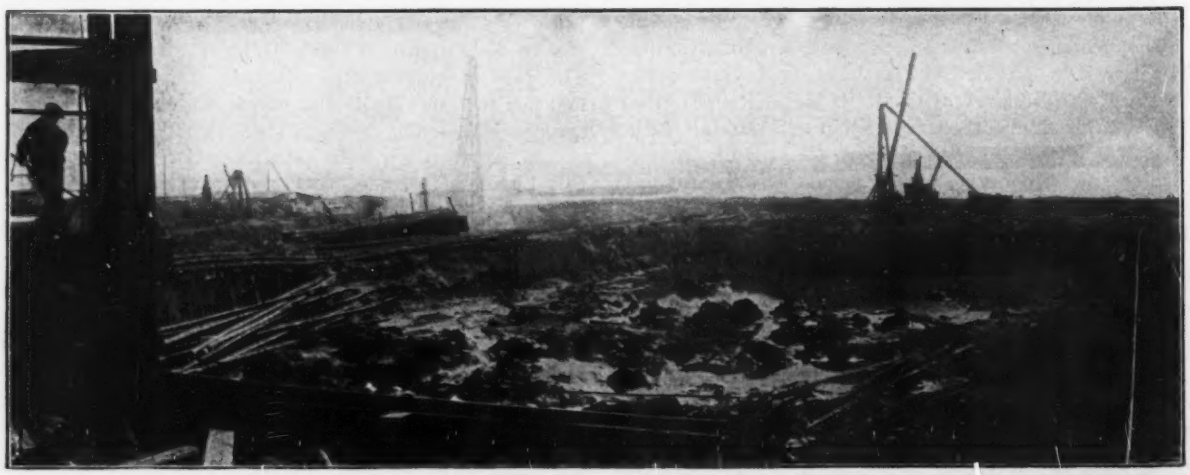
It has been the experience of the Navy Department that the great loads imposed on the caps of ways on which the largest naval vessels are constructed causes the pile heads to bite into them if made of soft wood. Accordingly, all of the piles in the two ways under construction are capped with oak, the use of full-length timbers or of smaller oak blocks under the pine sills being dictated by the height at each pile row between cut-off and the grade of the ways. The slope of the ways carries the deck 8 to 10 ft. above ground at the upper end. This part of each structure will be stiffened by bolting plank X-bracing to the piles. If, after the ways are completed, it is desired to make them more lasting, the piles can readily be incased in concrete down to water level, as ground water is near the surface over the area of the ways.

The hoisting equipment at each shipway will consist of traveling cranes spanning the structure. The ways are close enough together so that only three lines of footings are required for both craneways. The central line of footings and one outside line have already been constructed by day labor, and the other outside line of footings remains to be completed by the contractor.

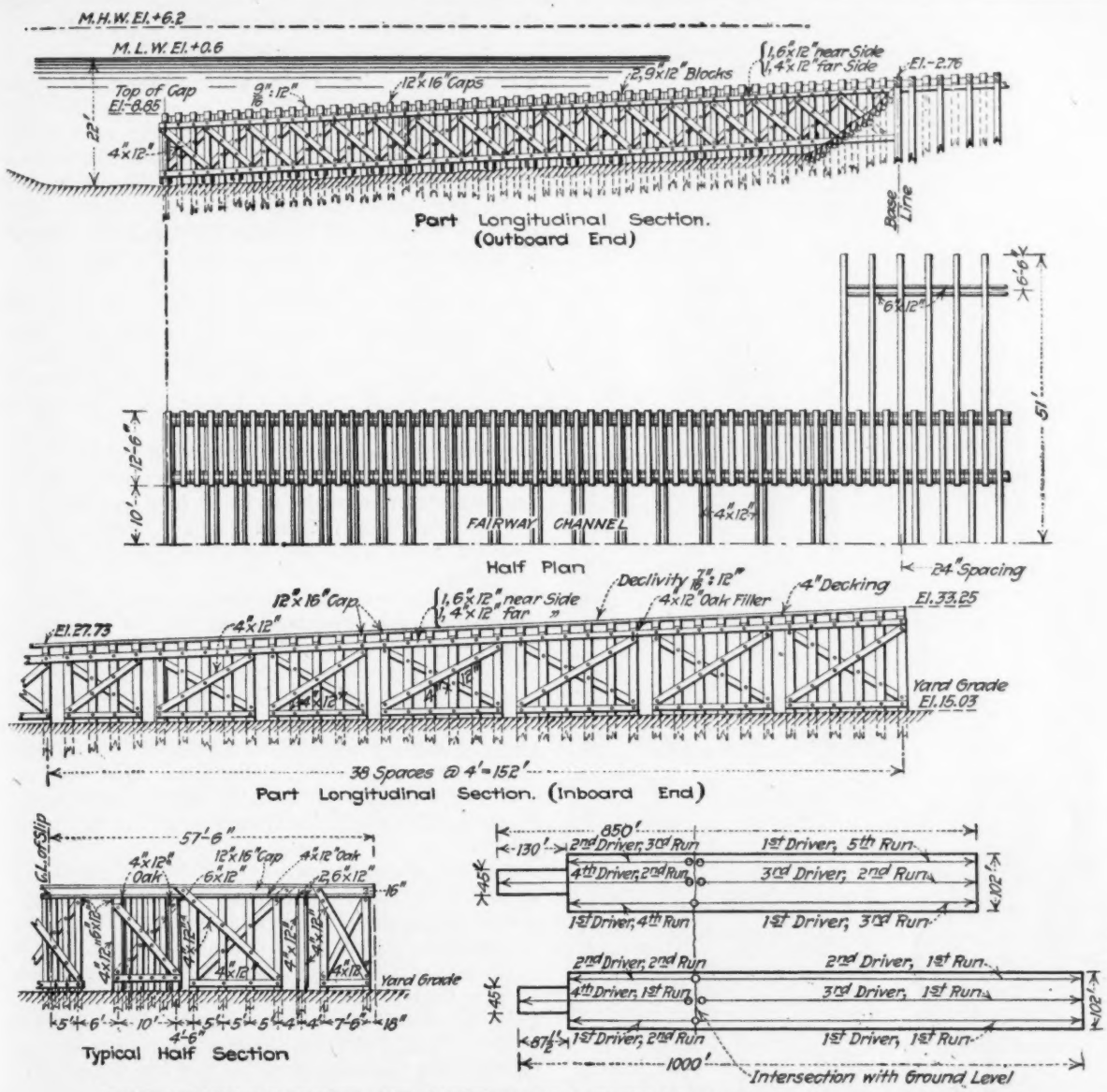
As considerable excavation was required at the lower end of each structure, the piledrivers were assembled near the point where the slope of the structures met the original ground line and worked up toward the inboard end while the excavation work was being completed. A dredge with a 2-yd. grab-bucket was used to remove as much as possible of the material under water and place it in a cofferdam surrounding the outboard ends of the ways.

The cofferdam consisted of a standard-gage trestle, on the outside of which was driven a single row of wood sheeting. A heavy fill of clay and sand was placed on both sides of this sheeting, which extended 3 or 4 ft. above high tide. A floodgate was provided at low-tide elevation in one corner of the cofferdam. The dam was unwatered with two 6-in. centrifugal pumps, and was generally kept dry with one. It answered admirably, except in one instance when an unusually severe storm raised waves that forced the sluice gate open and flooded the work. A small breach was made and a delay of three days on the outboard ends of the ways resulted.

The excavation was completed by two traveler derricks with grab-buckets, which started in where the slope of the ways met the ground line and worked backward downhill. As they neared the lower end of the ways, they were turned on a short radius to one side so as to bring the lowest part of the excavation within reach of their grab-buckets. These machines loaded dirt into dump cars for use in strengthening the coffer.



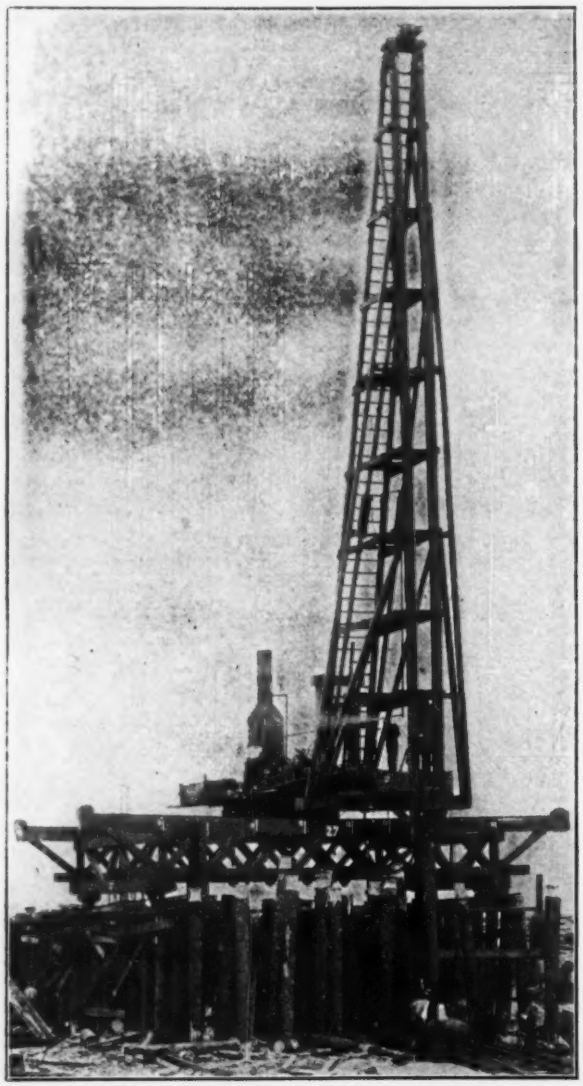
TRAVELER DERRICKS COMPLETED EXCAVATION FOR OUTBOARD ENDS BEHIND COFFERDAM



PILES HEAVILY X-BRACED AND CAPPED WITH OAK—DIAGRAM SHOWS COURSE OF DRIVERS

Of the four piledriver rigs used, each consisted of a trussed frame, two running on 35-ft. gage track for the outside rows, and two on 42-ft. gage track for the center row. On top of this frame an ordinary land driver with 57-ft. leads was mounted with its wheels running on a traverse track. The plans for these machines have been copyrighted. Very little time and rigging are required to move one of them, and for the particular work in hand they are preferred by the contractor to turntable rigs. The first advantage is that the machines roll on rails laid on the piles already driven, and do not require extensive cribbing. The second advantage arises from the unusual nature of the work. Because of the heavy loads imposed, the design of the deck of the ways would have to be uneconomical unless it were possible to count on accurate spacing of the piles. In driving them, therefore, it was necessary to provide a solid rig for "crowding" them back into place whenever they showed a tendency to run off. As the lower track can be secured against motion, and as the entire rig is rigid, it is possible with little waste of time to pull the leads into any position desired with the runner line and chain or block them so that they cannot move.

The narrow machines were first started on one way, driving uphill on the outsides. When these rows of piles were completed, these two rigs were rolled back to the ground surface, where the leads were jacked up and turned around on a turntable inserted on top of the trussed frame. One piledriver foreman made this change in seven hours. They then proceeded downhill, while a third, 42-ft. gage, driver was erected over the center space, running on track laid on the finished piles. This machine, starting at the middle, went up the slope to the top. Because twice as many piles were in the middle section as in one of the outside sections, a second 42-ft. gage machine was set up at the middle and carried downhill. While this work was in progress



SCALE PAINTED ON TRUSSED FRAMES

the first two drivers had been moved over and started on the inboard end of the second launchway. By the time this work was ready for the third driver the first inside rig on the first way had finished its work, and was moved over to the center of the second way.

All of the bolt holes for the timber framing were bored in place and all of the drift bolts driven with pneumatic tools, supplied by a compressor plant of 1000 cu.ft. capacity set up at the outer end of the ways. On this framing eight drills and four hammers were used. The piles to support the third line of craneway footings were driven with a land driver mounted on rollers, and concrete for these footings was placed with a portable mixer.

The work, with the exception of the crane runway foundations, has been carried out by The Foundation Co. under the direction of the Public Works Officer of the reservation for the Bureau of Yards and Docks of the Navy Department, of which Rear Admiral Frederick R. Harris was chief. It was begun on May 8, and it is expected that the ways in question will be completed by the 10th of February.

Weight of Counterweight Concrete Varied by Changing Mix

THE two sections of the tail counterweight of the Deering bascule bridge on the Chicago & North Western Ry. had to be made of different total weight because the front end of the bridge is skewed, and therefore one truss is longer than the other. It was thought desirable to keep the two counterweights alike in form and total volume, and to make their weights different by using concrete of different specific gravities.

A very heavy stone, called Fayalite, was obtained from a northern Illinois quarry. For the shorter truss, a mixture weighing 160 lb. per cu.ft. at 20 days was made, while the concrete for the longer truss weighs 168 lb. per cu.ft. The heavier concrete has a mix that is almost exactly 1:2:4 and the lighter concrete a mix of about 1:3:5.

The test specimens used for adjusting the mix to the desired weight were 6-in. cubes. Experiments showed that the mixture could be arranged to give a weight of wet concrete between 170 and 180 lb. The exact adjustment was made to suit the desired weight after 20 days of drying.

These counterweights were poured with cylindrical pockets to receive adjusting blocks 22 in. in diameter by 20 to 22 in. long. The total volume of pockets was made 7% of the total counterweight volume. It was estimated that the counterweight would balance the span when half of the pockets were filled with adjusting blocks, giving a possible adjustment of 3½% of the total amount of counterweight, either way. After final balancing the pockets were sealed with cement mortar spread on wire netting on frames set in the ends of the pockets.

The bridge carries three tracks. The channel is 145 ft. wide in the clear, and the bascule, of Strauss parallelogram type, crosses it at an angle of 74°. The skew of the front end is such as to make the rest pier parallel to the channel. The long truss is 186 ft. long from center of main trunnion to center of front bearing. O. F. Dalstrom describes the bridge more fully in the September, 1917, "Journal of the Western Society of Engineers." The total weight of the two counterweights is 2,360,000 lb., while the weight of the moving steelwork is 1,769,000 lb. The tower weighs 757,800 lb., and the machinery and trunnions 255,800 pounds.

Boston Catch-Basin Inspectors Are Scored

Gross inefficiency on the part of inspectors of catch basin cleaning in Boston is charged in a recent report by Guy C. Emerson, consulting engineer to the Finance Commission of the City of Boston. Mr. Emerson states that the duties of the general foreman of this work are performed in a perfunctory manner and that in a majority of many cases investigated the inspectors did not "have the catch-basins completely cleaned," while in "many cases" they certified as having been cleaned basins "from which no dirt had been removed" under the cleaning contract. The Finance Commission recommends that the number of inspectors be cut to two; that competent men be employed under the supervision of the engineering force; and that contracts for cleaning catch-basins be made hereafter on the cubic-yard basis instead of on the number of basins cleaned.

Water-Supply Specifications for National Army Cantonments Reviewed

Particular Attention Given to Quality, Quantity and Pressure for Camps To House 40,000 Troops and Many Animals—Per Capita Allowance 80% in Excess of That for Allies, To Meet American Conditions

By Dabney H. Maury
Consulting Engineer for Water-Works, Office of Cantonment Construction, Washington, D. C.

IN THE design of the water-works systems for the cantonments, the first point to be determined was naturally the quantity of water to be supplied. This was basic, and entered into every part of the design.

The considerations which affected the problem were, on the one hand, the desire to provide a supply sufficient, in the practical operation of the cantonment, for every reasonable requirement of the troops, for domestic use as well as for proper fire protection; and, on the other hand, the limited appropriations, the enormous prices of materials and labor, the difficulty of obtaining on short notice as much of either as was required for the simultaneous construction of 16 camps to house about 40,000 troops each, and, above all, the absolute necessity for haste.

It was at once recognized that some leakage and waste would be unavoidable; at the same time, it was believed that the concentration of all of the water fixtures in lavatories, where from forty to seventy outlets could be inspected almost at a glance, and the fact that, under military discipline, proper administrative rules could be enforced, would combine to make it an easy matter to reduce leakage and waste to relatively small amounts.

More consideration was given to the determination of the proper allowance of water than to any other question, and Messrs. Leonard Metcalf, of Boston, and George W. Fuller, of New York, who were advisory to the Committee on Emergency Construction and Engineering of the General Munitions Board; Clarence Goldsmith and W. M. Johnson, whose services were kindly loaned to the Office of Cantonment Construction by the National Board of Fire Underwriters; and Captain Leonard S. Doten, Q. M. R. C., who has for years had much to do with the design of the water-works and sewerage systems in the regular army posts, all devoted, with the writer, much time to the consideration of this important and fundamental question.

The basic quantities having once been agreed upon, the writer then prepared the General Specifications for Water-Supply, which formed part of the first general Instructions to Constructing Quartermasters, and which read, in part, as follows:

General Specifications for Water-Supply of National Cantonments

Quality: 1. The water-supply as delivered into the distribution system at the cantonments should at all times be clear and free from sediment. It should not contain objectionable quantities of iron, manganese or other mineral constituents. Above all, it must be absolutely safe from a sanitary standpoint. During the construction period, great care must be taken to see that the water-supply shall be maintained at all times in safe and sanitary condition. See regulations concerning camp sanitation during construction.

Quantity: 2. The general specifications as to the quantity of water necessary as hereinafter given in Articles 3, 4 and 5 are based on the assumption that certain administrative rules for the purpose of checking waste will be established and strictly enforced within the limitations of military requirements, as follows: (a) All fixtures shall be shut off when not in actual use; (b) the fire drill regulations shall make it the definite duty of certain designated individuals to shut off, as soon as fire alarm is sounded, every fixture from which water may be drawn for purposes other than fire fighting, except those necessary for cooking purposes; (c) the several brigade units in each cantonment shall make use of the showers at different hours, so that the very heavy peak load resulting from the simultaneous use of all of the showers may be avoided; (d) the use of water for sprinkling roadways and grounds, and for the animals, shall be so timed as not to coincide with the peaks resulting from the heavy draught for the showers.

Failure to enforce such rules will render inadequate all of the principal component parts of the entire water-supply, fire protection and sewerage systems and will be dangerous in case of fire. These systems as designed are of ample capacity for all legitimate ues.

3. No matter what may be the source of supply, provision must be made to deliver at the cantonment site at all seasons of the year and at all hours of the day, water at a rate of at least 55 gal. per capita per day for each man in the cantonment. For example, for a cantonment of 36,000 men, the daily supply should be not less than 2,000,000 gal. per day, equivalent to about 1400 gal. per min.; and for a cantonment of 45,000 men, the supply should not be less than 2,500,000 gal. per 24 hr., equivalent to about 1750 gal. per minute.

4. Provision must be made at the cantonment site, either through storage or otherwise, to furnish water to the distribution mains of the cantonment at all times, on three minutess' notice, and for a period of one hour, at rates 2.85 times as great as those just above specified; that is to say, at a rate of 4000 gal. per min. for one hour for a cantonment of 36,000 men, and at a rate of 5000 gal. per min. for one hour for a cantonment of 45,000 men.

5. The foregoing rates are intended in each case to include the water-supply required for horses and mules and for sprinkling and miscellaneous uses.

Per Capita Allowance Nearly Double Allies'

The allowance of 55 gal. per capita per day includes an allowance of 15 gal. apiece for the horses and mules. As there is about one animal for every three men, the net allowance for the use of the men is 50 gal. apiece per day.

This is about 80% more water, on the average, than is supplied in the British, French, Belgian, German or Canadian cantonments, and is larger than the quantity recommended by Captain Francis C. Harrington in his paper on this subject, published in "Professional Memoirs, Corps of Engineers," Vol. 8, No. 39.

It is a well-recognized fact that Americans use, and waste, more water than any other nation; but there are many cities in the United States where meters are in fairly general use, and in which the daily per capita consumption averages less than 50 gal., including all water wasted, leakage in mains and service pipes, flushing sewers, sprinkling lawns and streets, public and private fountains, the water used by the fire depart-

ment, and all sorts of industrial, commercial and manufacturing uses, these latter being often quite large in amount; in short, every drop of water that enters the distribution mains at the pumping station.

Three Cantonments Use Less Than 30 Gallons

Reports so far received from 14 National Army cantonments and one National Guard camp having a sewerage system and lavatory fixtures similar to those of the Army cantonments, show that only four of these 15 camps are exceeding 55 gal. per capita per day, and that of the 11 camps which have not exceeded the allowance, three have actually used less than 30 gal. per capita per day, with plenty of water for everybody in camp.

A number of complaints of insufficient supply have been received. In one of these cases the complaints were wholly justified, but were due entirely to the fact that the yield of the wells, which had originally been entirely sufficient, suddenly fell off to far below the required amount, and more wells were authorized. In no other cantonment has the supply provided been less than the specified allowance.

In one camp, located in a cold climate, the water used for steam heating, and for which no return system is provided, caused a loss estimated at from 500,000 to 600,000 gal. per day. This, when coupled with a failure to confine leakage and waste to reasonable limits, compelled the sinking of additional wells.

One other camp complained of being unable to keep water in its reservoir, and installed additional wells, and also made an emergency connection with a polluted river. In this case there was actually a sufficient supply of well water for all legitimate purposes, and had leakage and waste been checked, no shortage would have occurred. The emergency connection with the river was promptly ordered removed.

The ease with which some of the cantonments are keeping their total consumption down below 30 gal. per capita, with plenty of water for every one in camp, shows conclusively that the allowance of 55 gal. is a liberal one; and if the officer in charge of utilities in each camp be given the necessary men to keep the fixtures in order, and the authority to enforce regulations against waste, the water consumption can and should be kept within that allowance.

Pressure Specifications

Under the head of "Pressure," the General Specifications contained the following:

Pressure: 6. The water-supply should enter the distribution mains of the cantonment at a pressure of not less than 60 nor more than about 85 lb. per sq.in. In cantonments of less than 40,000 men, and where the topography is fairly level, and where no buildings occupy ground much higher than the point at which the water enters the distribution mains, pressures not greatly in excess of 60 lb. will be sufficient. When, however, the cantonment houses more than 40,000 men, or when some of the buildings are on higher ground than the point at which the water enters the distribution system, then higher pressures will be necessary in order to give proper domestic and fire service. These pressures are limited to about 85 lb. because of the fact that most of the wood-stave pipe which will be used will be designed for working pressures of about that amount.

7. Because of limited appropriations, it will be necessary to use wood-stave pipe for the distribution mains to the extent that it may be possible to secure this pipe within the time available. This pipe will be of the machine-wound type, so that the pipe may be shipped already made up; and wherever possible, it will be desirable to have men from the respective pipe factories on the ground to assist in the work of pipe laying.

8. On the typical water and sewerage plan, general plan, the layout of the water mains is shown. While the general location of the several units is subject to change to suit the topography of the various cantonment sites, the layout of the water mains in each unit should be adhered to as closely as possible, as the entire layout of all of the service pipes for each unit, and the purchase orders for the pipes and fittings, will be based on locating the water mains as shown on the plans.

9. It will be noted from the typical water and sewerage plan that there are in every case two lines of water mains running the length of the cantonment. If the supply be delivered into the distribution system at one end of the line of units, there should be two mains leading from the supply through the line of units and looped together at the far end. If the water enters at or near the center of the cantonment, then the two mains which run the length of the cantonment should be looped at each end.

10. Provided always that the initial pressures hereinbefore specified in Article 6 are at all times available, and provided further, that the spaces between the separate units are not materially greater than those shown in the typical general plan, and assuming that there will be no elevated storage available, then if the supply be delivered at one end, the cantonment will require two 12-in. mains running throughout its length, while in a cantonment with center feed these two mains will be 10-in. If, however, elevated storage can be obtained, sufficient in amount to tide over the peak loads hereinbefore specified in Article 4, and at elevations corresponding to the pressures specified in Article 5, and so located with regard to the general layout of the cantonment and especially with regard to the point of delivery of the supply to the distribution mains, that the elevated storage may be considered as a second source of supply, fed from the mains from a different direction, then the friction losses through the mains will be considerably reduced, and it may thus become possible to use mains of smaller sizes than those hereinbefore specified in this article. Typical details of the connections from supply to distribution system in each case are shown on the construction details for water.

It will be seen from the above that the specifications were flexible, as they had to be in order to meet the varying topography and other local conditions. At the same time, they fixed definitely the location of mains, hydrants and service pipes in each military unit, and the sizes of service pipe to each building, and they also prescribed certain sizes of mains for each set of conditions which could reasonably be anticipated.

Computing Size of Mains for Peak Load

Assuming in turn each of these sets of conditions, computations were first made to determine the size of mains required to furnish adequate domestic pressure and service at times of peak domestic load.

Other computations were then made to determine the size of mains required to deliver a fire flow of 2000 gal. per min. at 50 lb. at hydrants concentrated at the most distant part of the system, in addition to a distributed domestic load of one-quarter of the estimated domestic peak. If one of these computations called for larger mains than the other, the larger size was specified. The difficulty of securing standard rubber-lined hose, the fact that no building was more than two stories high, and consideration of friction losses, led to the decision to use 2½-in. mill hose, with small nozzles, and unusually close spacing of hydrants. In general, it may be said that for camps having end feed, the domestic requirements called for larger mains than did the fire requirements, while for camps having center feed, the reverse was true. In all of the camps it was possible to approximate the center-feed condition, and in many cases the mains could be looped at the ends. These advantages were at least partially

offset by the fact that, because of broken topography at many of the sites selected, the various military units were often widely separated, thus greatly increasing the length of mains required.

In general, it may be stated that the National Army camps have, all things considered, higher standards of water-supply and of fire protection than the average city of like size.

Unit Cost One-Fifth Average City Water-Works

It may also be stated that the cost of reproduction new of the average water-works system in a city of 40,000 inhabitants, at present prices for materials and labor, and exclusive of service connections, would average over $2,000,000, or more than $50 per capita. As nearly as can be ascertained at present, the cost of the water-works of the 16 National Army cantonments, including service connections to within 5 ft. of the buildings, has been less than $11 per capita, or say about one-fifth as great as the reproduction cost new today of the average municipal water-works system.

Perhaps 25% of this great difference in cost of the entire system is due to the fact that about 70% of the distribution mains have been wood-stave pipe instead of cast-iron pipe, the cost of wood-stave pipe being on the average about 60% of that of cast-iron pipe. The greater density of population in the camps has also contributed materially to reduce the cost of their water-works. But when every possible allowance has been made, the comparison of cost cannot be other than favorable to the camps.

Finally, and infinitely more important, is the time comparison. The time allowed for planning and completing a water-works system for a city of 40,000 population would, under ordinary circumstances, be about three years; whereas with the most difficult material, labor and transportation conditions ever known in this country, the water-works for the 16 Army cantonments have been planned and completed in a little over three months.

Utility Staffs at National Army Cantonments Organized on Military Basis

Camp Meade Utility Service for 40,000 Men and 12,000 Animals in Charge of 343 Officers and Privates and 35 Civilian Employees in Eight Subdivisions, with Major at Head of Whole

By John M. Goodell

THE operation of the public utilities at the national army cantonments by officers of the Quartermaster Corps, National Army, is one of the most interesting examples of public management on a large scale ever undertaken in this country. A water, sewerage or lighting plant is generally planned and built without great haste to serve a population all of which will not become consumers for 15 years or more. The surplus capacity when such a plant goes into operation is adequate to meet all unforeseen demands, and gives the manager ample time to provide additions before they are seriously needed. In the cantonments, it was necessary not only to design and construct the plants with unprecedented haste but also to keep down their capacity to the minimum consistent with safety, so as to avoid the delay due to needless work as well as to eliminate unnecessary expense. The maximum capacity required to meet the demands at each cantonment was carefully estimated, on the assumption that waste would be curtailed by military regulations strictly enforced. Consequently, these rapidly built plants have gone into operation, serving men accustomed to the lavish American use of electricity, water and fuel, under virtually full-load conditions, placing an unprecedented burden on the officers in charge of the utilities.

Last September, as these military cities approached completion, Gen. I. W. Littell, who had charge of building them, directed the construction quartermaster at each cantonment to prepare complete maps and records of the utilities under his charge, for the assistance of the officers who would be intrusted with their operation. On account of the unusual conditions the officers in charge of planning and building the utilities wished to have their operation instrusted exclusively to experienced operating engineers, who were to report to General Littell, in order that the operating staff might have the guidance of the specialists who planned the plants and the useful experience gained at one cantonment might be made available with the utmost promptness to the officers of the other cantonments.

Supreme Control by Commanding General

While it has proved possible to place the operation of the plants at each cantonment under competent managers, drawn from important posts in civil life for these duties, the military authorities have not yet found a way to place these operating officials under General Littell and thus have a homogenous managing staff like those of the great utility-owning corporations. The military authorities apparently recognize the value of such an organization, but it does not accord with the general organization of the army, and they hold that under the present intense strain of equipping and training an enormous number of men, it is undesirable to make a radical innovation in the organization for that work. Consequently, each of these cantonments is an independent city, so far as its utilities are concerned. Supreme control is in the hands of the commanding general, and his influence on the operation of the utilities is like that of the mayor of a city. If he is familiar with the difficulties of managing public works, the superintendent in charge is able to do better work at lower cost than is the case where the mayor does not realize the responsibilities laid upon the manager and

his leading assistants. In the case of the cantonments, the commanding generals and their staffs are merely temporary tenants and their control of the utilities is liable to result in disturbance of the organization with every change of commanders.

The engineer who visits several of the cantonments is impressed by the great variety of the duties laid upon the officer in charge of utilities and by the difference between the operating conditions in different cantonments. The difference between the heating systems in the cantonments at Battle Creek and Columbia, and between the water-supplies at Atlanta and Fort Riley, is so decided that the operating methods found best at one place will probably not be best at the other. But in all general features the management is the same and is based on an operating scheme prepared in September by General Littell's staff. Every utility in a cantonment, except the telephone service, which is under the signal corps, is managed by the "officer in charge of utilities," who also repairs the building and carries on all new construction work. The officers in charge of the 16 cantoments are shown in the accompanying list.

Camp Meade Taken as Typical

The manner in which all these varied duties are discharged can be best shown by taking a typical case and describing the actual organization. This may not prove to be the organization best adapted for the work, but it is the best it has proved possible to obtain under the existing conditions. The men must be taken from the ranks of the privates undergoing training. They should be skilled in their prospective duties, and such skilled men are generally of the class which company commanders are very reluctant to turn over to the Quartermaster Corps. Moreover, the prevailing spirit at every cantonment is to put into training for fighting every man who can possibly be spared from nonmilitary duties. The ease with which men are placed in jobs about municipal works is replaced in the cantonments by the most critical scrutiny of the need for any job which will take a drafted man from the training field. This condition is reflected by the undermanned organization for managing the utilities in some cantonments visited recently, but it is a condition which will undoubtedly be improved as the officers in command learn from experience that the operation of public utilities by an incompetent and inadequate force always causes serious inconvenience to those served.

The management of the utilities at Camp Meade, about half way between Baltimore and Washington, may be taken as a typical example. The camp quartermaster, an officer on the staff of the commanding general, is in charge, and the officer in charge of utilities, with the rank of major, is in direct control. He has an executive officer, a lieutenant, to manage the office routine, who is assisted by a stenographer-sergeant. There are also three trouble clerks, sergeants, whose hours of duty are so arranged that there is always somebody at the office to receive any notice of unsatisfactory service and take whatever action is warranted by the complaint.

Each report of trouble is recorded on a blank giving the date of the complaint and its serial number, the department concerned, the situation of the defective condition, the name of the person making the complaint

HALT!
SERVE BY SAVING!
There is plenty of water if you don't waste it.
DON'T WASTE IT.
Don't leave water running.
Don't turn on a stronger stream than you require at Faucet or Shower.
Report every leak you see.
The water supply system for this Camp has been designed to furnish a total of 55 gallons per day for every man in Camp, with reserve capacity for hourly peak loads, break-downs or fires.
One Camp has already reported that it is using only 30 gallons per capita per day, and that everyone has plenty of water.
BUT
if leakage and waste are not checked, there won't be enough water for you.
SHUT IT OFF!

TO DISCOURAGE WATER WASTE POSTERS WERE DISPLAYED IN EACH NATIONAL ARMY CAMP LAVATORY

[The original was 11 x 14 in., with the larger letters printed in red.]

and the nature of it. The directions for making the repairs are then written on the blank and it is given to the proper man for carrying them out. A carbon copy of the blank is kept in a filing case until the repair man reports the completion of the work. By glancing through this file it is possible to discover promptly how rapidly the organization is meeting the demands on it.

Eight Subdivisions at Camp Meade

There are eight independent subdivisions of the operating organization at this cantonment, some of which the officer in charge considers adequate for their purpose, while others are capable of betterment. These subdivisions are the following:

1. Light and Power—This is under a master electrician, a sergeant, who is carrying satisfactorily responsibilities of such a character that they are the duties of a commissioned officer rather than a sergeant. He is assisted by a clerk, a sergeant, and directs the work of three squads. These are (a) outside line squad, comprising a foreman and six privates (b) inside work squad, comprising a foreman sergeant and six privates, and (c) a transformer station squad consisting of an operating sergeant and two privates.

2. Ice and Refrigeration—The superintendent of this branch is a lieutenant, who has under him a chief refrigerating engineer, who is a sergeant, three operating engineers, sergeants, and 15 privates who serve as oilers, ice pullers and laborers. The fuel and supplies are delivered to the plant and the ice removed by another branch of the camp quartermaster's organization.

3. Supplies—This branch is under a lieutenant, with a sergeant-stenographer, and has three subdivisions. The first, with a mess sergeant and four cooks, prepares the food for the men engaged in the operation of the utilities. The second, with a sergeant and three privates, has charge of the stores for which the officer of utilities is responsible. The third, which has to keep the equipment in repair, has a sergeant in charge of the shop and repairs, two sergeants who act as machinists, five privates as helpers and a blacksmith-sergeant.

4. Engineering—This is in charge of a lieutenant with two stenographer-sergeants, three draftsman-sergeants, a field party consisting of a sergeant and two privates, and 10 building orderlies who act as general utility men and clerks.

Water-Supply and Sewerage Subdivided

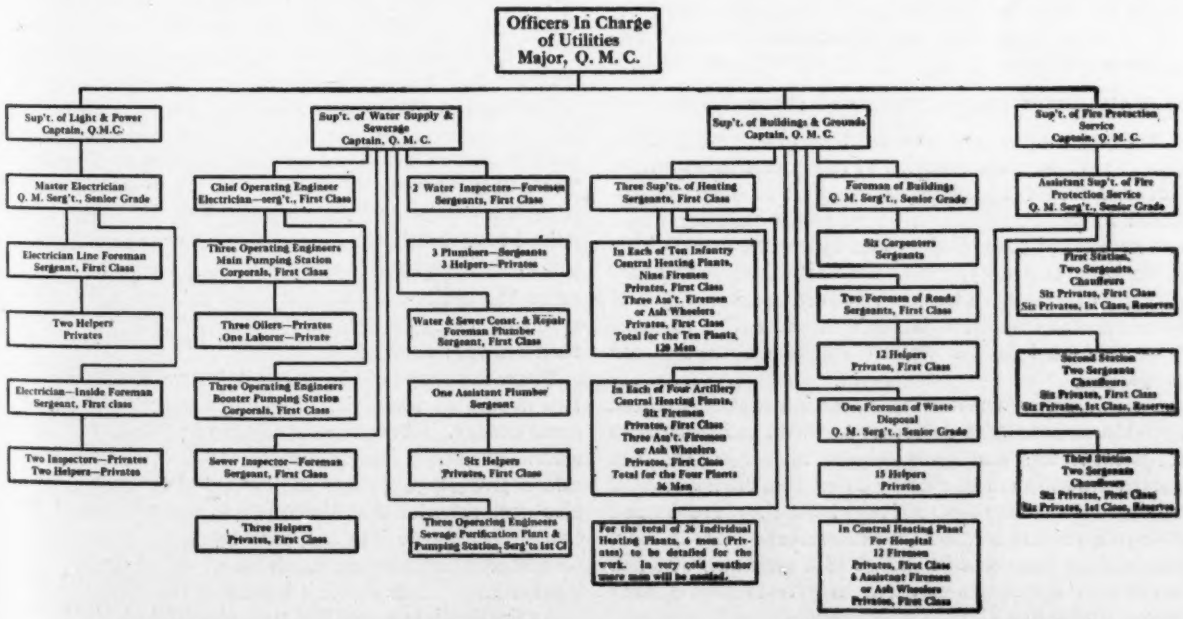
5. Water-Supply and Sewerage—This branch is in two subdivisions, one attending to general maintenance and repairs and the other to the operation of pumping and purification plants.

The maintenance and repair work on the 52 miles of water mains and sewers and the plumbing in the buildings is under a lieutenant. The outside water repairs are made by a foreman sergeant and six privates, and a similar organization looks after the outside sewer repairs. The plumbing work is done by two inspector-sergeants, six plumber-sergeants and six privates acting as helpers.

The pumping and filtration plants are under a lieutenant, assisted by a chief operating sergeant. The low-lift pumping station contains three electrically-driven pumps of 1000 gal. capacity per minute and one of 750 gal. and is run by three operating sergeants and three privates serving as oilers. The filtration plant, using alum as a coagulant, contains two 100,000-gal. tanks for sedimentation, six 500,000-gal. filters and two 100,000-gal. tanks acting as clear wells, and is in charge of three operating sergeants with three privates as helpers. The high-lift pumping station operating against a head of about 175 ft. has the same number of units as the low-lift station and is run by three operating sergeants and four privates as oilers. The sewage-disposal plant consists of two septic tanks, each with four compartments, and a chlorinating device between the third and fourth compartment, and is run by two operating corpoprals and two privates for night duty.

A strong effort was made to install a small laboratory with a chemist and bacteriologist, having the grade of sergeant, and a private as helper. The purification plants are small and liable to be overloaded at times, and the warnings against dangerous conditions which such a laboratory located on the spot would give have been urged as justification for the small expense involved. This proposition has been successfully opposed by the medical department, which holds that all such work should be under its charge and conducted in connection with the medical analytical work at another part of the cantonment.

6. Buildings and Grounds—The work done by this part of the organization falls under two branches. The first is in charge of the heating plants, but the extent of the charge varies in the different cantonments. In some the whole management is under the officer in charge of utilities, while in others more or less of the work is done by the men of the regiments and the utilities officer inspects it. The latter plan is followed at Camp Meade, where there are 128 steam boilers in officers' quarters and a central heating plant at the base hospital with two high-pressure and six low-pressure boilers. The organization is under a lieutenant. At the hospital plant the force consists of a chief operating sergeant and two


Officers In Charge of Utilities Major, Q. M. C.
Sup't. of Light & Power Captain, Q.M.C.
Master Electrician Q. M. Serg't., Senior Grade
Electrician Line Foreman Sergeant, First Class
Two Helpers Privates
Electrician—Inside Foreman Sergeant, First class
Two Inspectors—Privates Two Helpers—Privates
Sup't. of Water Supply & Sewerage Captain, Q. M. C.
Chief Operating Engineer Electrician—serg't., First Class
Three Operating Engineers Main Pumping Station Corporals, First Class
Three Oilers—Privates One Laborer—Private
Three Operating Engineers Booster Pumping Station Corporals, First Class
Sewer Inspector—Foreman Sergeant, First Class
Three Helpers Privates, First Class
2 Water Inspectors—Foremen Sergeants, First Class
3 Plumbers—Sergeants 3 Helpers—Privates
Water & Sewer Const. & Repair Foreman Plumber Sergeant, First Class
One Assistant Plumber Sergeant
Six Helpers Privates, First Class
Three Operating Engineers Sewage Purification Plant & Pumping Station, Serg'ts 1st Cl
Sup't. of Buildings & Grounds Captain, Q. M. C.
Three Sup'ts. of Heating Sergeants, First Class
In Each of Ten Infantry Central Heating Plants, Nine Firemen Privates, First Class Three Ass't. Firemen or Ash Wheelers Privates, First Class Total for the Ten Plants 120 Men
In Each of Four Artillery Central Heating Plants, Six Firemen Privates, First Class Three Ass't. Firemen or Ash Wheelers Privates, First Class Total for the Four Plants 36 Men
For the total of 36 Individual Heating Plants, 6 men (Privates) to be detailed for the work. In very cold weather more men will be needed.
Foreman of Buildings Q. M. Serg't., Senior Grade
Six Carpenters Sergeants
Two Foremen of Roads Sergeants, First Class
12 Helpers Privates, First Class
One Foreman of Waste Disposal Q. M. Serg't., Senior Grade
15 Helpers Privates
In Central Heating Plant For Hospital 12 Firemen Privates, First Class 6 Assistant Firemen or Ash Wheelers Privates, First Class
Sup't. of Fire Protection Service Captain, Q. M. C.
Assistant Sup't. of Fire Protection Service Q. M. Serg't., Senior Grade
First Station, Two Sergeants, Chauffeurs Six Privates, First Class Six Privates, 1st Class, Reserves
Second Station Two Sergeants Chauffeurs Six Privates, First Class Six Privates, 1st Class, Reserves
Third Station Two Sergeants Chauffeurs Six Privates, First Class Six Privates, 1st Class, Reserves

ORGANIZATION CHART FOR THE OPERATION OF UTILITIES AT NATIONAL ARMY CANTONMENTS
This chart was drawn to apply to Camp Devens, Ayer, Mass., and was modified to suit other cantonments. It does not include any of the personnel for laundry, refrigerating plant or telephone service

OFFICERS IN CHARGE OF UTILITIES AT NATIONAL ARMY CANTONMENTS

Corrected to Dec. 17, 1917

Maj. Paul Doty, Camp Grant, Rockford, Ill.
Capt. E. W. Briggs, Camp Devens, Ayer, Mass.
Maj. E. B. Whitman, Camp Meade, Admiral, Md.
Maj. C. A. Watrous, Camp Dodge, Des Moines, Iowa.
Capt. H. L. Hall, Camp Gordon, Atlanta, Ga.
Maj. Walter E. Spear, Camp Upton, Yaphank, N. Y.
Maj. Murray Warner, Camp Dix, Wrightstown, N. J.
Maj. William McK. Scott, Camp Lee, Petersburg, Va.
Maj. Eugene Betts, Camp Jackson, Columbia, S. C.
Maj. R. L. McDonald, Camp Sherman, Chillicothe, Ohio.
Capt. A. E. Barbour, Camp Zachary Taylor, Louisville, Ky.
Maj. T. A. Leison, Camp Custer, Battle Creek, Mich.
Maj. G. F. Huestis, Camp Pike, Little Rock, Ark.
Maj. W. L. Benham, Camp Funston, Fort Riley, Kan.
Maj. Frank H. Todd, Camp Travis, San Antonio, Tex.
Maj. John C. Hays, Camp Lewis, American Lake, Wash.

assistant operating sergeants with 12 privates as oilers, coal handlers and ash wheelers. The low-pressure boilers in the officers' quarters are under a chief inspector-sergeant, four district inspector-sergeants, a private acting as clerk and 74 privates acting as firemen. There is also a repair gang comprising a fitter sergeant, an assistant fitter corporal and two privates as helpers.

The second branch is under a lieutenant with a stenographer-sergeant. Part of its work is done for the cantonment division of General Littell's organization and part for the construction and repair division, which is a part of the old military organization before the declaration of war. This branch has three subdivisions. The first is under a sergeant who is an architectural draftsman and estimator, assisted by a sergeant-inspector, a sergeant-carpenter foreman, four carpenter-sergeants, four carpenter-corporals, 12 privates as carpenters' helpers, two sergeant-roofing foremen, and four privates as roofing helpers. These men keep the 1800 buildings in repair and do the job carpentry about the cantonment. The maintenance of the 20 miles of concrete and gravel roads is attended to by three sergeants acting as road foremen, 24 privates as helpers, six privates as teamsters, a sergeant and private operating a road roller and a sergeant operating a road machine. The teams used in this work are cared for by a stable-sergeant, a blacksmith-sergeant and two stable orderlies.

GARBAGE CANS WATCHED TO LESSEN WASTE

7. Conservation and Waste Disposal—Careful attention is paid to the prevention of any unnecessary waste. Garbage cans are watched to see that food is not prepared in too large quantities and that nothing which can be worked over by the cooks is thrown away. This is an important duty, for in the early days at the cantonments there was a tendency toward great waste. The same careful inspection is made of the ashes, to make sure that coal is not wasted and the fires are run properly.

This branch of the service is under a captain assisted by a lieutenant. The detection of waste is intrusted to three inspectors and three helpers, all sergeants. The wastes are collected in cans by 30 civilian employees and delivered to a loading station where they are turned over to a private contractor who removes them in cars. The loading station is in charge of a sergeant, who has under him a foreman-sergeant, a private as assistant foreman and five civilian employees.

8. Fire Department—There are four fire equipments in the cantonment, each consisting of a Ford truck with hose and chemical apparatus, but only three companies have been organized yet. Each consists of a sergeant and six privates. The whole organization is under a lieutenant acting as superintendent and a sergeant acting as assistant superintendent. In case a fire is discovered, the telephone central station is notified and the fire companies are given the position of the fire from that station.

The building area at Camp Meade is about three miles long and two miles wide. There are about 1800 structures on this area, and the cantonment has been constructed to accommodate 40,000 men and 12,000 animals. The utilities division not only has to operate the utilities but must do all the carpentry, plumbing and steam fitting in the place. The force actually employed on the work when it was visited by the writer comprised 343 officers and privates and 35 civilian employees.

Flow Conditions in Irrigation Flumes Unstable

Tests Made by Reclamation Service Show That Ample Freeboard Is Needed When Velocities Approach Critical Stage

FLOW in a flume, with water at about the critical depth, was discovered to be unstable by tests made in 1916 on the Congo flume of the North Platte project, U. S. Reclamation Service. The results of the tests are given in a recent issue of the *Reclamation Record* by John S. Longwell, assistant engineer, and the following matter is taken from his report.

The flume is of steel, of the Hess type, with smooth interior. It is semicircular, with an inside diameter of 10.823 ft. It is straight—240 ft. long between headwalls. The profiles of subgrade, water surface and top of flume are shown on one of the drawings. The water-surface profile shows that the flow is decidedly unstable, especially at the upper and lower ends of the flume. This condition, together with the decided drop and jump at the lower end, was found in every test, and indicated that the flow was at or near the critical stage.

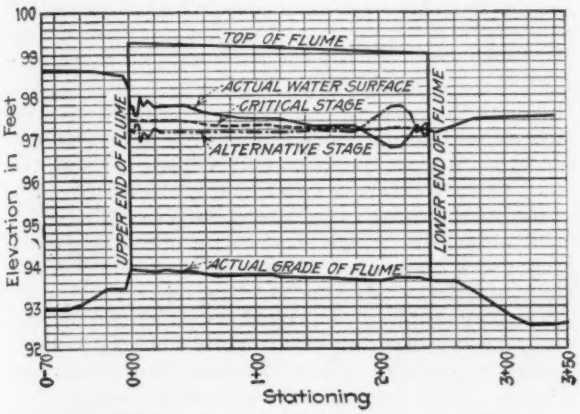
Taking the discharge of 235 sec.-ft., various depths in the flume were assumed and the resulting area, velocity and velocity-head for each depth were computed. These data were plotted as shown on the second diagram, with the depths (D) as abscissas and the energy required to maintain the flow at these depths as ordinates. The energy required is equal to $D + h_v$, where D represents the static head and h_v the velocity head. The resulting energy curve for a flow of 235 sec.-ft. was then drawn, as shown.

From the shape of the curve it follows that there are two depths at which the flow will take place with the same energy. These two depths are known as the lower alternative stage (stage of high velocity), and the upper alternative stage (stage of low velocity). The curve also demonstrates that there is one depth at which the two stages merge into one, this being the lowest point on the curve and hence the depth of flow requiring the least energy. This depth is known as the critical depth.

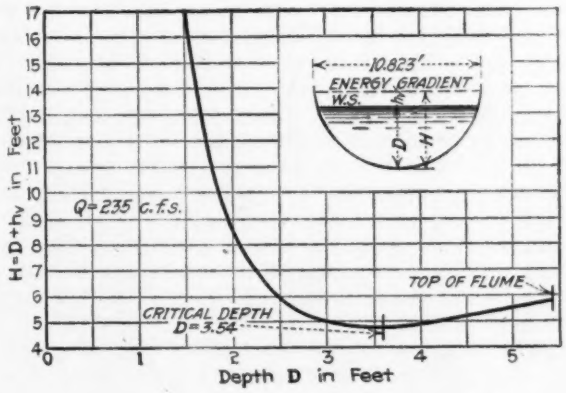
As the depth becomes less than the critical, the flow is taking place at the high velocity of the lower alternative stage, and if obstructed will jump and flow under the condition of the upper stage of low velocity. With the flow taking place at or near the critical depth, as shown

by the flatness of the curve at this point, any slight change in energy will cause a decided change in the depth. It is thus to be expected that in such a case the water surface will be very rough and the depth will shift back and forth along the curve. A jump may be expected if the flow is at all restrained. (See *Transactions*, American Society of Civil Engineers, Vol. LXXX, pp. 338-420.)

The velocity at which the water will flow at the critical stage is termed the critical velocity and may be shown to be equal to $V = \sqrt{gA/T}$, the corresponding velocity head being $h_v = A/2T$, in which V = critical velocity; g, acceleration due to gravity; A, cross-sectional area of flume, and T, width at water surface.



PROFILES SHOW FLOW CONDITIONS IN IRRIGATION FLUME



ENERGY CURVE OF FLOW OF WATER IN FLUME

(See letter by Julian Hinds in *Engineering News* of Dec. 7, 1916, p. 1007.)

From this formula, the depth at which the critical velocity is developed may be obtained. For the case in hand this was found to occur at a depth D of 3.54 ft., with a velocity of 9.09 ft. per sec. This gives the coordinates for the critical stage as follows: $D = 3.54$; $D + h_v = H = 4.82$. These were plotted, and furnished the lowest point through which the energy curve must pass.

Having obtained the critical depth, $D = 3.54$ ft., the dotted line indicating this depth of flow throughout the flume was plotted on the profile. This line is called the "critical stage." The actual water surface for the test is very close to the critical stage throughout the flume, and Mr. Longwell states that from the explanation given above it follows that the extremely unstable condition of flow is to be expected.

In the profile the actual water surface is taken as one stage, and for each observed elevation the opposite stage is picked off the "energy curve" and plotted. These points are then connected, and this line represents the alternative stage at which the water could have flowed in this particular flume with the same energy with which the flow actually took place.

It is observed that up to Sta. 1 + 83 the flow takes place at the upper alternative stage, but that the actual was so close to the critical stage that the flow was very rough and unstable, and with a slight change of energy could easily have shifted to the high velocity or lower alternative stage. At Sta. 1 + 83 the flow line drops below the critical stage and assumes the lower alternative stage.

At Sta. 2 + 30 the flow jumps to a point near the critical stage and then drops again to the lower stage. This rise at Sta. 2 + 30 was probably caused by the rise in the subgrade. Had this rise been a little more pronounced the flow line would have taken approximately the elevation 97.78, as shown for the alternative stage. However, it probably would not have fully attained this elevation, because of eddies through which the energy is dissipated.

The above data show the unstable conditions of flow which may be expected to take place in a flume with the water flowing at or near the critical stage. The necessity for consideration of the above principles in connection with flume design is no doubt apparent, and Mr. Longwell believes that for all flume designs in which the water is flowing at a high velocity similar investigation should be made before final designs are prepared. In case of flow at or near the critical stage additional freeboard should be provided.

Suggest Old Bridges for Chicago Canal

Various commercial interests, and a few engineers, attended a public hearing in Chicago recently to enlighten a committee of the Association of Commerce as to the policy to govern the type of bridges over the main Drainage Channel, the bridge under discussion being at California Ave. On account of the urgency of the case and the fact that few of the swing bridges now spanning the canal are equipped with operating machinery, the engineers suggested that a second-hand railroad swing bridge for $30,000 would answer the purpose for several years until a more definite lakes-to-the-gulf waterway program is under way. This would take the place of the proposed 140-ft. bascule costing more than ten times the railroad span and impossible to obtain at present, for the Secretary of War has denied the Sanitary District's request for priority in delivery of steel. Regardless of the suggestion, the Association has gone on record as opposed to setting aside the policy of asking for a clear 140-ft. span as it does for the Chicago River.

Portable Houses for Overseas Forces Built in Record Time by New Methods

Details Are Adapted to Sawmill Instead of Planing Mill Machinery and Permit Easy Erection as Well as Interchangeability—Good Management Responsible for Unusual Results

FORESEEING that the landing of an American army in France would result in the necessity for portable buildings, the Committee on Emergency Construction of the War Industries Board called upon Perry R. MacNeille, architect, New York City, to make a study of the demands and to coördinate the many different ideas which had been worked out and could be found in commercial designs. In addition to these, the portable houses of the allied armies were also considered. Mr. MacNeille, who had had a wide experience in the design of industrial villages, put his own draftsman to work on the problem, and called into consultation the manufacturers of portable houses as well as the representatives of certain firms that he knew had been studying the problem. A report was finally drawn up, agreed upon by the committee—and filed, since there was no actual demand for buildings of this type. All this work had been completed about Sept. 1, last year.

Without warning came a cablegram from France addressed to Col. William H. Rose, Engineer Officer in Charge, Engineer Depot, Washington Barracks, D. C., requisitioning housing of just the type that the committee had been studying. Col. Rose sent Maj. Robert S. A. Dougherty, purchasing officer of the depot, to the Committee on Emergency Construction, where he learned of the work that had been done. Mr. MacNeille was sent for and persuaded to take charge of the designing.

Drafting Office Borrowed

Although Mr. MacNeille had agreed to take charge of this work, he had no drafting force in Washington. However, the firm of J. H. Burton & Co. had been studying portable houses with the intention of preparing to supply the needs of the devastated regions of France at the close of the war, and for that purpose had maintained a drafting office in Washington. This was turned over to Mr. MacNeille who, with the help of all who were interested, in a remarkably short time turned out a design which was acceptable to the Engineering Depot. It has seemed impossible properly to place credit for this design, since there were many who contributed, but it is probable that the panels are the result of Mr. MacNeille's study of the requirements of shelter and the necessities of transportation; and that the framing, in its construction and in most of its details, was the work of J. H. Burton.

So much for the preparation of the plans. The work of construction, however, was a far more complicated undertaking. In the opinion of most of the firms who bid on the work, at least six months should be allowed for the completion of the contract. But most of them were accustomed to the planing mill as the location normal to the manufacture of portable houses, and did not realize that all the details of the accepted design could be fabricated at the sawmill with but slight additions of machinery. Neither did they possess the knowledge of where materials could most readily be obtained, nor in what quantities. But the study of demands, the ascertainment of the methods through which they can be filled with the least effort, and the provision against possible future obstacles, is the function of an engineer. So, in presenting the story of this to the readers of *Engineering News-Record* no apology is made because of the fact that the details of the design are simple and are required to possess but little structural strength. For the ability to convert 25,000,000 feet of lumber into buildings which can be erected without the aid of skilled laborers, and to accomplish this within two months when people accustomed to this type of work demanded as much as six months as a minimum, is managerial skill of the highest order. And management is engineering.

This is actually what was accomplished. The accepted design was drawn up, not only with the idea of portability and ease of erection, but with the realization that the manufacturing process could only be carried on with speed and despatch at the point of the production of lumber. The design which was finally adopted possessed all these points of value. It was on account of these factors that an untried scheme was accepted in the face of designs which had been the standard of other manufacturers for years. There has been no little criticism of the committee, and of Mr. MacNeille in particular, on account of this, but no one has been successful in proving that any other method of design or of handling the contract would have produced the houses in the time required—for the Engineering Depot allowed only sixty days for the completion of buildings which would inclose 2,500,000 square feet of floor space.

Design Is of Extreme Simplicity

Reference to the details of the design will show the extreme simplicity of the basic idea, and the ease with which it could be realized at sawmills with but slight addition to the machinery usual at such places. In fabricating the typical floor and wall panel, tongue-and-groove flooring of any width from 2½ in. to 6 in. may be used. These boards are nailed together with grain crossed, forming units which in no case are larger than one man can handle alone. Between the two laminations is placed a layer of tar paper, and the individual boards are nailed at each intersection. This gives a virtually airtight and weatherproof unit of considerable inherent strength, which when properly incorporated into the building becomes more than merely a sheathing and adds substantially to the structural strength. All panels are constructed so that they form a ¾-in. ship-lap with the adjacent panel.

The roofing panels are simpler in detail and construction than the panels used for floor or siding, since they are a single ply and are held together with four battens, 3½ in. wide so placed as to space the roof panel on the

rafters and afford lateral support to the trussing. These, like the other panels, are built of planks varying in width from 2½ to 8 in. and boards as short as 3 ft. 2¾ in. long may be employed. With the exception of the panels at the ends of the building which must provide for the eave, the length of the roof panels is 7 ft., the width of two floor or siding panels. The roof panels themselves are not watertight nor weatherproof, since they are covered with a composition roofing after the building has been erected.

Exclusive of the end panels, which, of course, must fit up into the gables, the siding panels are of three designs—one plain, one provided with a sash, and one with an opening for a hinged door. As will be noticed from the drawings, the designs of these are all very simple. Much care was taken in designing the details of these panels, and while they appear ridiculously simple, this simplicity was reached only after many trials. The adopted dimensions of sills, jambs and lintels was a matter of much study and, ultimately, of practical experimentation. In their present form assembly is extremely simple, and the hanging of sash is reduced to a point where the minimum of skill is required. While the doors are shipped in their panels, sash are shipped separately, and swung after the building has been erected. Corner posts, sills, plates, belt courses and the individual members of the trusses are furnished to exact size and bored with all necessary bolt holes.

Since the erection of a building had been considered as an integral factor of its designing, a brief description of the process will illustrate why many of the details of design were adopted.

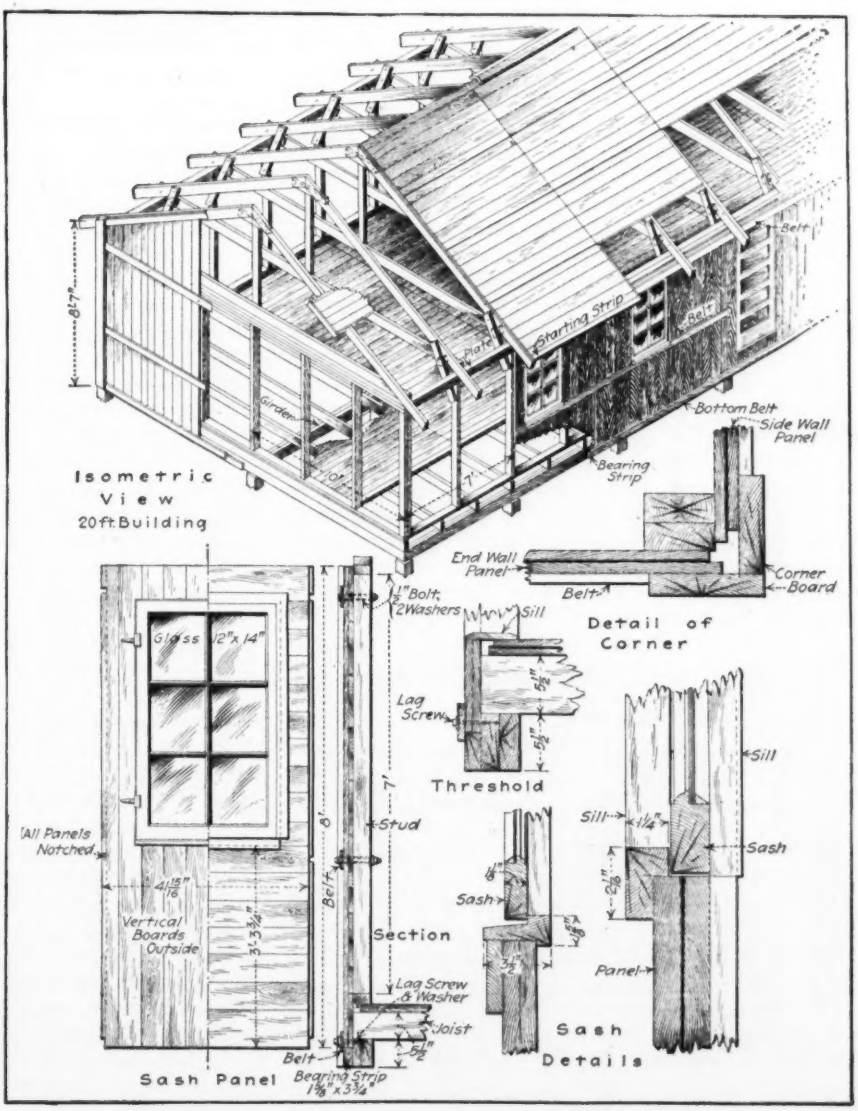
For the typical building, which is 20 ft. wide and 217 ft. in length, posts or concrete piers are placed on 7 ft. centers at each side of the building. These, together with a third line on the axis of the building, carry the sills, which are formed of two 2 x 6's sized to exact dimension as to sections but of random lengths. These are spiked together, laid on the piers, and carry the floor joists, which are spaced 28 in. on centers.

The floor panels are laid with their long dimension parallel to the center line of the building, and after they are spiked to the joist, the "floor sill" is spiked in line with the outside of the sills. This serves to cover any inequality of the panels and, as will be shown shortly, is a factor in the stability of the building.

To the sill is spiked what is styled a "bearing strip" cut to exact dimension and placed flush with the under side of the sill at the outside of the building. Upon this bearing strip rest the sidewall panels.

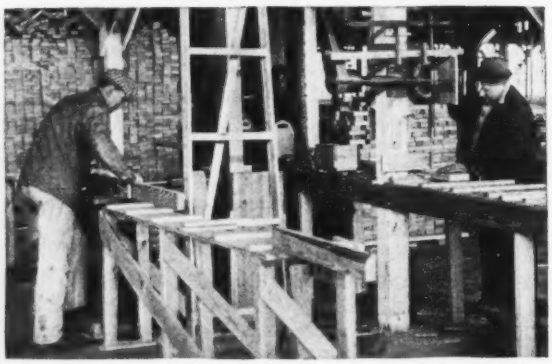
After the corner posts are set in place and plumbed, the side panels are raised and placed on the bearing strip. As can be seen from the drawing, the bottom corners of the panels are notched to pass a lag screw, which passes through a hole bored in a belt strip located over the joint between the sidewall panels and the bearing strip, and is screwed into the sill. The sidewall panels, therefore, have a fulcrum at the floor sill and a point of leverage at the belt course. When the roofing trusses are in place this detail adds much to the lateral stability of the house.

Behind each joint between panels is placed a stud



SIMPLICITY OF ERECTION AND LIGHT WEIGHT OF UNITS CHARACTERIZES THE DESIGN

ALL BOLT HOLES WERE DRILLED AT SAWMILL BEFORE BUNDLING

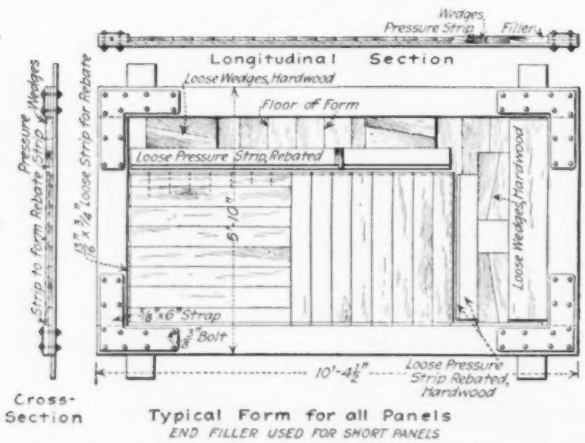


PANEL FORM ON HORSES GAVE GREATEST SPEED ON PIECE WORK

sized to dimensions and length. This stud is bored with two holes through which bolts pass from the bell course, serving to hold the sidewall panels in place. After a series of studs and side-wall panels are in place, two 2 x 4s, sized to dimensions, are nailed to the top of the studs, forming a plate which is toenailed into position. These 2 x 4s are furnished random lengths and are laid so as to break joints, thereby very securely tieing the walls of the building together.

The trusses which support the roof panels are assembled and bolted together on the ground. Each member is fabricated to exact size and bored to receive the necessary bolts. One of these trusses rests on the plate directly above the top of each stud, and since the tie member of the truss is cut exactly 20 ft. long, it forms a gage for the placement of the sidewalls. After three trusses have been placed, starting from the end truss, a gage or starting strip is nailed to the end of the rafter and the roof panels are then laid on the trusses, having been passed up from the inside of the building.

The erection is carried on in such a manner that after a short length of building is completed, sidewalls, studs, trusses and roof panels are being erected simultaneously and but a short distance apart. The hanging of doors and windows follows the placing of roof panels, and with the placing of braces the building is completed.



SPECIAL FORM SPEEDS ASSEMBLY OF LAMINATED PANELS

As an example of how quickly the erection of these buildings is carried on, three men laid all the floor timbers and all the floor panels in a building 20 x 217 ft. in two hours and a half. This, of course, could only be accomplished if all details of the various pieces were considered not only in the light of their purpose and ease of manufacture, but also with due regard to facility of handling on the work. To shorten the period between the delivery of the material on the ground and the moment when the buildings are ready to be occupied, all units are painted. Furthermore, they are numbered and lettered, so that with a key and a short description of the building they can be erected easily and without difficulty by anyone. Another interesting feature of the design is that the panels and various other units are so designed that it will be a simple matter to dismantle these buildings with a wrench and re-erect them in many different-sized units, which can be used not only for residences but for farm buildings.

Sawmills in Mississippi, Louisiana and Texas had been consulted and were ready to assume a share of the work. Of these only one had had any experience in the actual work of portable house fabrication—the remaining fourteen had to receive instruction and make additions to their plants. But careful studies had been made of the best methods of handling the work through small gangs, and the factors to be determined during the filling of the larger contract were but few.

But in addition to this, realizing that the contract was one primarily of organization, H. B. Coho, who was connected as production manager, in a free-lance capacity, with the United Lead Co., was called by long distance at his hotel in Pittsburgh and employed to take care of the production end. Mr. Coho knew nothing of lumber, but having an intensive knowledge of organization through his experience with the United Lead Co. also with the U. S. Cartridge Co., in the work of producing cartridges for the allies, was uniquely fitted for this particular work. Within 24 hours he was in consultation with Mr. Burton, had been introduced to the mill manager, was organizing the various elements, and furthermore had started the construction of four additional factories which were to supplement the work and increase the speed of the mills which had been retained for this work.

A Call for State Supervision of Engineering

Bad Conditions in Profession Attributed to Lack of Thorough Organization—Should Government Certify Fitness?

By Clarence T. Johnston
Professor of Surveying, University of Michigan

FOR many years I have hoped to witness the birth of an engineering profession. We have been content to drift, representing an element that is considered essential to industry, and occupying a position in society comparable to that of the hired man, while our brethren in neighboring fields have demanded and received recognition.

During the period when technical schools were of minor importance and when but few trained men were in active practice, the condition of the engineer could be explained, to his own satisfaction at least. The engineer had no headquarters then; he was engaged in railway location to a large extent, and he had but little opportunity to look about him and study his place in society.

However, the rapid growth of engineering schools and the increased demand for trained men in nearly every branch of human activity are duplicated in every scientific branch of learning. If the physician and the dentist found it possible to develop wonderfully along scientific lines and at the same time to create a feeling of mutual confidence and respect as a foundation for strong and efficient professional organizations, there seems to be no good reason for tardiness on the part of engineers.

Only a few engineers have ever been much concerned in a campaign of this kind and those who have participated have failed to reach any agreement. Only here and there has an attempt been made to analyze critically the attitude of the engineer toward his work and his relations with other engineers and society in general.

Where men of similar training fail to organize to protect themselves against imposters and incompetents, such organization being needed to preserve their self-respect and justify their existence in the eyes of the world, their influence is limited to that of individuals, and their opportunities for leadership are almost completely eliminated. The American engineer stands virtually alone among the many trades and professions of the country.

Engineering Organization Passive

Engineers are able to agree when technical problems are under discussion. They display some interest in "professional ethics." Beyond this point their organizations are passive. Individuals rise above the common level and often fail, insofar as public opinion is concerned, because they are obliged to stand alone. If anyone has a doubt as to the truth of this statement, let him read the history of engineers who have risen to high places in Government service or in the several states.

The training and experience of the engineer are such that he develops a judgment not found elsewhere in society. The engineer should be in position to lead in many fields of government, local, state and national. The people are crying for the kind of advice the engineer alone can give.

It is known among political experts that engineers are dependable servants. They lie down when they are told to do so. The politician has been able to wreck nearly every branch of public service which was organized on an engineering basis. He knows that he is dealing with individuals and, regardless of how much demoralization and corruption may follow in his path, no protest will come from the great body of engineers of the country.

Generally speaking, the American engineer has been more concerned in his own financial success than he has been in supporting the reputation of his brethren as a body. His altruism has been colored by selfishness. He will continue to follow any convenient leader until he organizes his forces to support leadership.

The Remedy

After we have accepted a general diagnosis of our ailments we need not waste much time searching for a remedy. We have some leading cases and valuable precedents. The time has passed when there should be any discussion as to the character of the preliminary treatment. Engineers must provide machinery for self-examination. They must clear the atmosphere of doubt as to ability and moral stamina, by state supervision of the right to practice. Every profession which now enjoys a cohesive membership, public respect and a definite place in the body politic has fought for these benefits in a campaign staged for the purpose of demanding recognition and support only for those qualified to practice because of training, practice and moral stamina.

The plight of the engineer was a sorry one during times of peace. His indifference in years past threatens to destroy much of his intrinsic value in this great contest between the engineers of the world. The selfish and conservative policies of those who have unfortunately assumed leadership in former years must now give way to broader conceptions, as a matter of patriotism and loyalty. If each state had long since provided by legislative enactment the necessary authority for a strict supervision of the practice of engineering, the engineer today would be a recongnized factor in the war.

State supervision of practice brings about a gradual elimination of the unfit. It provides a record of the training and experience of every practitioner. It brings engineers together so that they become a united force for or against policies in which they should naturally manifest an interest.

If engineers were thus organized today they could perform a great service for the nation. Engineers would be classified. The Government could easily be furnished with complete information relative to the special ability of every engineer in the country. An organized effort of this kind would command respect, and many engineers would be called into Government service to aid those who are to outline a successful war policy. Engineering talent would not be dissipated and lost, as it threatens to be under existing conditions. The engineers who were so fortunate as to be called to service would have behind them a single profession rather than a disorganized group of individuals.

Telescope Sections for Latest Timber Snowsheds

Ventilated Roofs and Side Windows Other Features Developed by Southern Pacific Company in Sierra Nevadas

WHERE the Southern Pacific railroad passes through the Sierra Nevadas in crossing from California to the Nevada plateau, the snowfall is often 20 to 30 ft. per annum and it has been found necessary to provide about 30 miles of snowsheds on this division. The design of the structure itself has varied little since the line was built, the sole consideration being protection at minimum cost. In recent years, however, with careful study of the maintenance problem and an opportunity to try out various suggested improvements, it has been possible to make the snowshed system safer and much more flexible, at the same time requiring less attention, without materially increasing the initial cost and maintenance.

In order to provide a means for quickly isolating sections of the snowsheds, a plan for telescoping short lengths at regular intervals has been developed and is regarded as highly successful. These telescope sections are put in at 5000-ft. intervals, and it is planned to reduce this interval to 1000 ft. as rapidly as possible. The telescope sections have a maximum length of 96 ft. and are built either on straight track or curves; manifestly, they can be located on curves only when the radius is constant. The section which moves is mounted on rails and is moved with a locomotive by means of a cable.

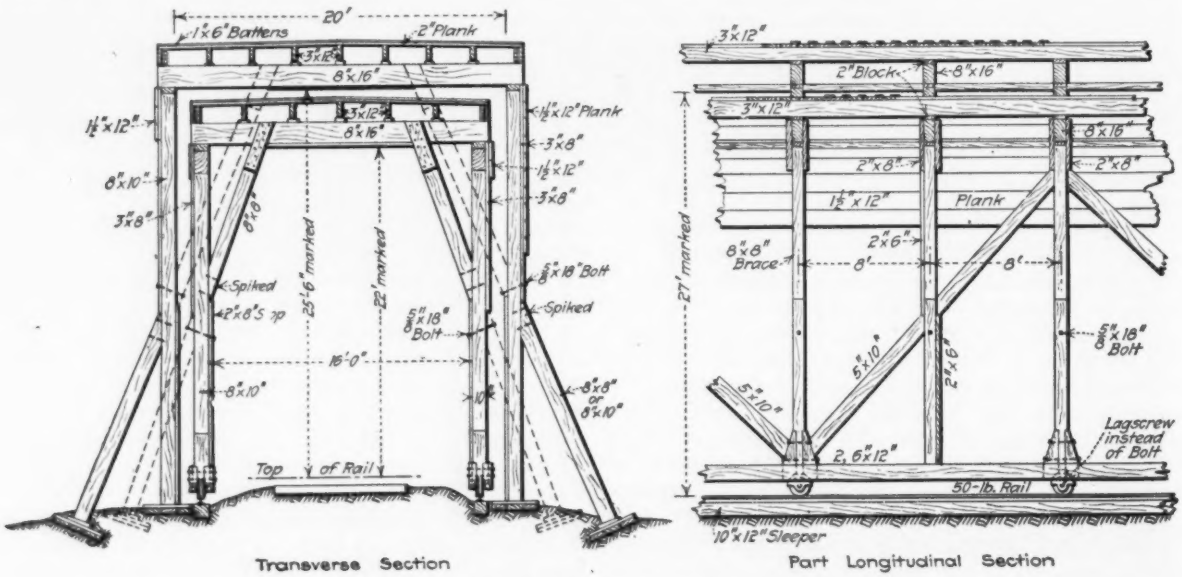
The telescope section is built up with standard clearances and differs from standard design chiefly in being mounted on rails rather than fixed foundations. The frame of the movable section is lightened somewhat by the use of braces, which are taken away before moving. The dotted lines in the accompanying sketch indicate how the open structure is made as strong as the permanent sections without the interference to movement which permanent braces would entail.

In order that the route through the snowsheds might not be objectionable to passengers, it has been found possible to use shutters on the sides at the height of passenger-car windows, so that at least one side of the train commands a view of the country traversed. To accomplish this the siding has been omitted for a 4-ft. strip at the proper height, and shutters which just fill this space are built in sections to be slid up and down between the plumb posts. These shutters, set inside the plane of the fixed plank on the sides, can be moved

WINDOW SHUTTERS SIMPLY CONSTRUCTED

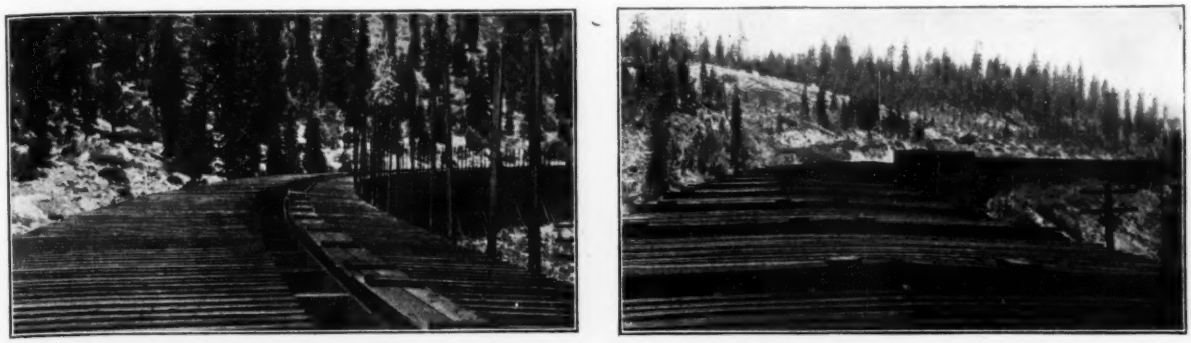
up or down between strips, and when put up for the winter are held in position by a wooden button that prevents the shutter from sliding down its groove.

Several types of ventilators in the shed roof which would allow the rapid escape of smoke and fumes in the summer season have been tried out. Two of these, shown in the accompanying illustrations, are lateral and longitudinal types, respectively. Of these two, the



Transverse Section — Part Longitudinal Section

DETAILS OF TELESCOPE SECTION OF SNOWSHED



LONGITUDINAL AND TRANSVERSE SMOKE VENTS—NOTE COMBING BOARDS IN LEFT-HAND VIEW, TELESCOPE SECTION IN BACKGROUND OF RIGHT-HAND VIEW

lateral or transverse hinged section has proved far superior and has been adopted as standard. With this design it is found that the smoke, which tends to follow the train, escapes from the openings, placed at frequent intervals, much more rapidly than where the smoke must travel in a transverse direction to reach the central longitudinal opening.

Where locomotives regularly stand for any length of time within the snowsheds, it is customary to provide a stack ventilator consisting of a rough timber chimney, 14 ft. high, extending the full width of the shed.

Experience with snowsheds on this division has shown that the snow not only has a tendency to form in drifts on the roof but sometimes extends out over the edge and thus supports, by cantilever action, an overhanging weight sufficient to threaten the stability of the structure. To prevent the formation of these overhanging drifts it has been found worth while to make use of "combing boards," which consist of 3 x 12-in. planks nailed vertically to the side in such a way that about 12 ft. of the planks projects above the roof. These planks are spaced 2½ to 3 ft. on centers, and no overhang drifts have formed where they have been in use.

As built on the Southern Pacific, the sheds are constructed of "Shasta pine" cut near the site, which costs the company only about $10 to $15 per 1000 ft. B.M. to cut and deliver on the work. This wood has an average life in these sheds of about 20 or 22 years, which might be divided into three periods, as follows: During the first 10 years virtually no repairs are required. The next 5 or 10 years require increasing repairs, particularly the renewal of footings and sections where dampness has access to the wood. In the third period, from the fifteenth year on, according to conditions, the items requiring replacement include braces, caps, joists and in fact all parts up to the point where it is considered cheaper to renew the shed entirely. This year there is being renewed a section of shed which has been in service 27 years—probably the longest life on record for this division.

As renewed under present prices the cost varies, according to the design of the section, from $12 to $14 per lin.ft., this figure being a rough average of single and double-track construction. The average maintenance per foot per annum is figured at about $1.60. This includes renewal made necessary by fire, slides and decay, and also the cost of fire patrols and interest on the first cost.

Tests of snow taken from shed roofs show them to have frequently a weight of 40 lb. per cu.ft. Based on a safe margin for the 15-ft. snow load likely in this region, all sheds have been designed for a uniformly distributed load of 300 lb. per sq.ft. This loading is approximately the same as would result if the sheds carried a train of consolidation locomotives.

In recent years concrete footings have been made standard, and wherever plumb posts are renewed or a new section of shed is built, the company's standards now call for the use of 16 x 18 x 8-in. concrete blocks at each footing. If necessary, two or more such blocks are used to raise the footing up to the point where the timber will in all probability be above moisture line.

TELESCOPE SECTION OF SNOWSHED PARTLY OPENED

Clearing Snow from Country Roads

Snow may be removed from roads by using a road-drag in reversed position, so that it will push the snow into the side ditches. This is recommended by the Missouri State Highway Department, which suggests also that this use of the drag in this position will reduce the crowning of the road, which is generally excessive on earth roads in Missouri.

Spalling of Reinforced Concrete in Moist Location

Surface Destruction in Upper Part of Measuring Tanks—Concrete 12 Years Old—Was 1:2:4 Mix of Good Quality

By F. E. Turneaure
Dean, College of Mechanics and Engineering, University of Wisconsin

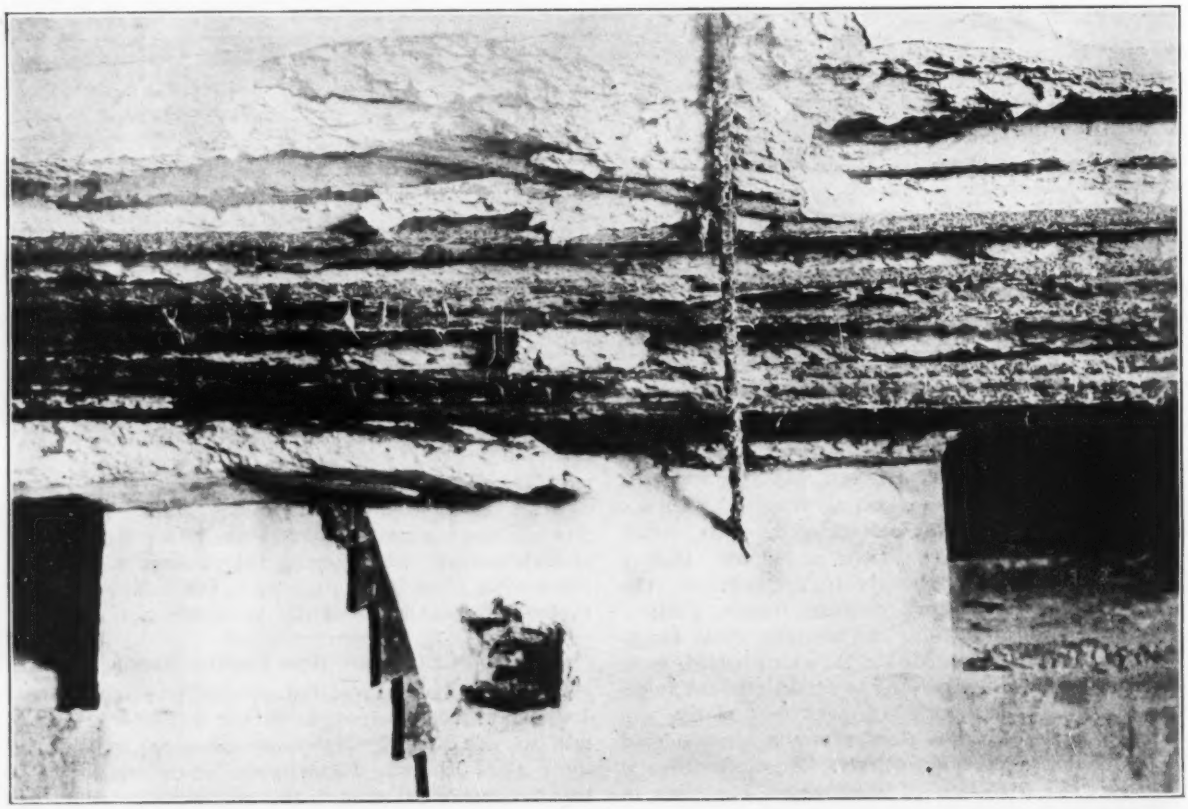
THE accompanying photographs of reinforced-concrete construction illustrate what may happen under certain circumstances. The concrete in question is in the Hydraulic Laboratory of the University of Wisconsin, and the conditions are as follows:

In the basement of the building there are several reinforced-concrete measuring tanks for use in hydraulic experiments. These tanks are the full height of the basement, about 8 ft., and are constructed by merely placing reinforced-concrete division walls at the desired intervals. The floor above the tanks is the main floor of the laboratory, and consists of a reinforced-concrete slab supported by the division walls between the tanks and other division walls of the basement. The thickness of the floor slabs is about 8 in., and, at the particular point in question, the panel is oblong in shape and is reinforced in one direction only.

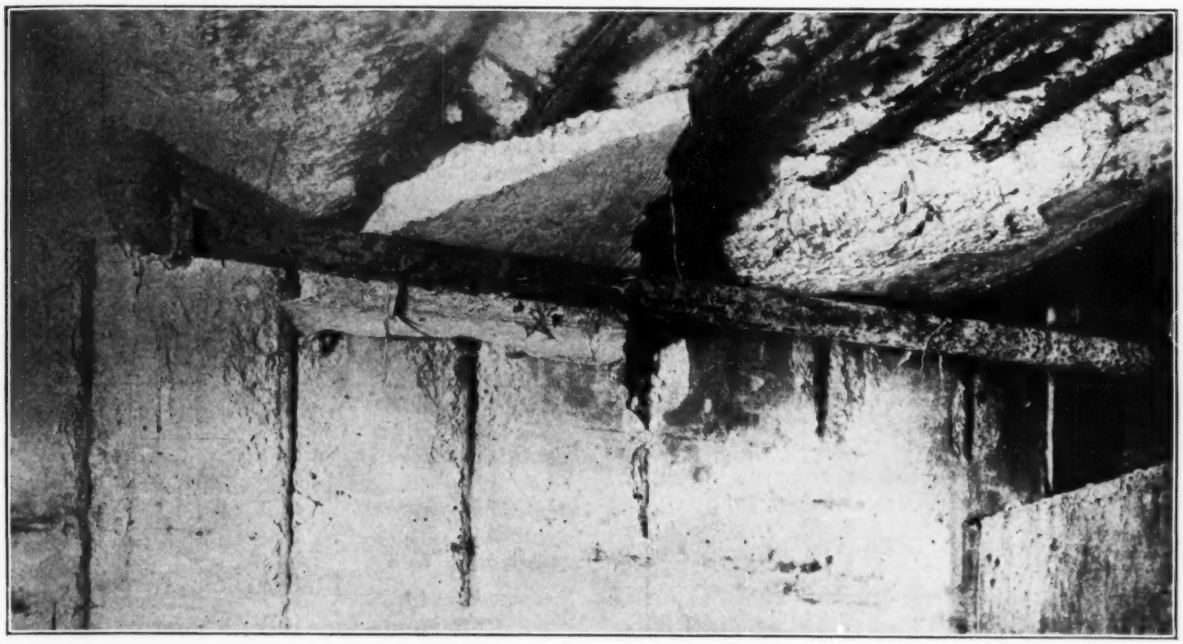
The photographs show what has happened to a portion of the lower surface of these floor slabs, and also to one of the division walls between the tanks. In the case of the floor slab, the concrete below the rods has broken away from a considerable area, and the rods are badly rusted. In the case of the wall, the rods are not so closely spaced, and the spalling of the concrete has occurred only immediately over the rods. The thickness of the concrete underneath the floor rods is 1½ in. or more, but the covering on the wall rods is much less.

The building was erected about 12 years ago, and the writer had charge of the concrete work. The concrete was made of about 1:2:4 proportions, and was of good quality. Where pieces have broken away, a thoroughly good quality is now indicated. The steel was comparatively clean of rust, and this particular part of the building was constructed in August or September. The floor rods were laid upon small transverse rods resting on the forms in order to raise the rods above the forms. It may be said, however, in the light of more recent experience, that the concrete covering of the rods was undoubtedly insufficient for the conditions to which this particular part of the structure was to be exposed. Rods similarly covered in other parts of the basement where a free circulation of air exists have shown no tendency to rust, and there is no spalling of the concrete.

On account of the use to which these tanks are put, the concrete in the walls is exposed alternately to water and air, and the ceiling is constantly moist. As a result of these conditions, it appears that the steel has badly corroded, and in corroding has forced the concrete to spall off. Probably this corrosion began at a point where the rods were very slightly covered or



SPALLING OF FLOOR-SLAB CONCRETE OVER WATER TANK BELIEVED TO BE DUE TO RUSTING OF REINFORCEMENT, STARTING AT SOME POINT OF THIN COVER



SPLITTING OF CONCRETE CEILING OVER WATER TANK IN TWELVE YEARS' SERVICE; SIMILAR ACTION IN PARTITION WALL

possibly were actually exposed, but having once begun and the concrete having started to spall off, the rusting of the rods has continued progressively, so that the concrete has broken away to a depth of 1½ to 2 in. Note also, in one of the views, the corrosion of the small iron pipe suspended below the floor.

Only two sides of the tank in question showed the rusting effect. The corrosive destruction seems to take place only where the rods are not imbedded sufficiently deep in the concrete. Apparently on two of the sides of the basement the rods are imbedded deeper than on the other sides. On one side the concrete is chipped loose from practically every reinforcing bar in the upper half of the wall, but here the surface of the bar is not more than ½ in. below the wall face.

In general, the upper half of the walls shows the greatest effect. This is where the wall is not ordinarily submerged. The lowest foot of the walls, which is nearly always submerged, shows practically no rusting effect.

The views show perhaps the worst parts of the structure, particularly with reference to the ceiling, but the rest of the ceiling is more or less affected. None of the concrete split away farther than the central flame of the rods.

The case is no doubt rather extreme, but it seems to show what may happen under special circumstances, even where the workmanship is what might be considered as ordinarily good. An occurrence of this sort raises very serious question as to the permanency of concrete under moisture conditions similar to those of this case. The least that can be said is that great care must be taken to cover all the rods to a considerable depth with good, dense concrete.

Computation of Plate-Girder Flange Riveting Discussed

THE old-established method of calculating the pitch of plate-girder flange rivets, namely, dividing the product of rivet value and girder depth by the shear, has been under attack by bridge engineers in India recently, and was the subject of dicussion at a meeting of the Indian Railway Bridge Committee at Simla, Aug. 13-18, 1917.

A new method was proposed some time ago by Rendel & Robertson, which takes into account the fact that one rivet cannot fail alone, but that the longitudinal shear at the rivet line is resisted by the entire line of rivets acting together. Their method, which they call the parabolic method, aims to keep the curve of rivet resistance outside the curve of flange stress. The committee did not approve of this method, although it agreed that the old method mentioned above—which by the way, has been the method heretofore standard with the Railway Board—is incorrect.

The committee tentatively expresses a preference for the method used by the Burma Railways, which consists in calculating the horizontal shear at the dividing plane between web and flange according to the usual formula for longitudinal shear. Applying the formula to this case gives: Pitch of rivets equals, moment of inertia of girder section, multiplied by rivet value, divided by the total vertical shear and by the statical moment of the flange about the neutral axis.

The method recommended will be seen to be the logical accompaniment of the now common method of calculating plate-girders by moment of inertia, based on the view that the cross-section of a plate-girder is equivalent to a solid section. It was proposed in the present case by G. A. Glascott, deputy chief engineer of the Burma Railways, in 1907, in reply to criticisms of Rendel & Robertson.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Who Will Answer?

Sir—What is the matter with a college education?

A COLLEGE graduate in electrical engineering wanted with one or two years' experience for work along technical lines in a permanent position on telephone-office equipment in Buffalo, N. Y. Will pay $16.00 per week for man with one year's experience and $18.00 per week for man with two years' experience. Address communications to Telephone Company, 297 Michigan St., Buffalo, N. Y.

AT ONCE, experienced pile driver wanted and dock-builder foreman for Government job, Philadelphia; average wages $60.00 per week; write giving experience in detail and earliest date of starting. P454—Eng. News-Record, Phila.

These two ads were clipped from the "Positions Vacant" columns of your issue of Dec. 6, 1917.

M. J. HENOCH,
Sioux City, Iowa. Building Inspector.

Why One State Department of Health Makes Water and Sewer Plans

Sir—Until I came to West Virginia no one was more strongly opposed to the designing of water-supplies or other engineering works by state health departments than I, and I still believe that this practice should be avoided whenever possible. There is, however, so much inertia in most West Virginia towns, that lacking, as we do, laws to require sanitary improvements, they would never be undertaken, or at least would be long delayed, unless the state Department of Health started the ball rolling by preparing preliminary designs. These designs are always left in a condition that requires the services of an engineer to complete them. In this manner not only is work not taken away from the various engineers in the state but jobs are actually created for them where, as individuals they stood small chance of arousing the necessary enthusiasm.

A few examples should prove of interest and illustrate my point as well. The little town of E—— had been wrangling over a water-supply for more than six years, with one side insistent that a competent engineer be employed and the other side asserting that local talent was equal to the task. We realized that at the rate things were progressing the supply would never be acquired. Consequently, I met with the mayor and city council one night and talked over the situation, with the result that my department prepared tentative plans and specifications. These were turned over to the town for submission to the "competent engineer" already mentioned. The inspection work and minor surveys during construction were made by the "local talent." Everybody seemed perfectly satisfied, and the water-supply was put in use within three months of the time we gave them aid. The "competent engineer" changed our plans and specifications in some places, but we had no objection. Our object was to see the water-supply installed.

In another case, in the town of W——, we found that a certain politician was swinging the new water-supply his way and that it was only a question of time before he would sell the town a certain dam site. Our knowledge of the district showed us that the spot was not suitable, so we stepped in and made a careful survey of the region and designed a complete water-works for the town, including reservoir and filtration plant. The drawings, together with the report, were submitted to the town, the result being that the community is to build a filtration plant. Our drawings were not used, however, and a consulting hydraulic engineer has already been employed.

On only one occasion has an engineering undertaking been carried through solely on the plans prepared by my office, and that was a sewage-disposal plant for a county court house 42 miles from the railroad. The job was not big enough to warrant an engineer spending two full days simply driving over mountain roads.

Our office has yet to receive a compliment regarding our attitude from any of the consulting engineers of the state.

MAYO TOLMAN,
Chief Engineer, West Virginia State Department of Health.
Charleston, W. Va.

Formula for Oblique Bearing on Timber Questioned

Sir—Apparently attention has not been called to a formula which, though fundamentally in error, occupies a prominent place in a standard engineering text, and is deemed of sufficient practical importance to justify its presence in Merriman's "American Civil Engineer's Pocket Book" together with a table of derived values.

This is "Jacoby's Equation" for computing the allowable intensity of compression for timber on surfaces inclined to the fibers, derived by Prof. Jacoby on page 253 of "Structural Details." It is a simple matter to show the fallacy involved in the derivation. Referring to the sketch, the derivation is as follows:

s' = Allowable unit-stress on the ends of fibers.
s'' = Allowable unit-stress on the side of fibers.
s = Allowable unit-stress normal to an inclined surface which makes an angle of θ with the direction of the fibers.
P' = Total compression corresponding to s'.
P'' = Total compression corresponding to s''.
P = Total compression corresponding to s.

$dy = ds \sin\theta$; and $dx = ds \cos\theta$

For a section of unit thickness:

$$P' = s'\,dy = s'\,ds\,\sin\theta$$
$$P'' = s''\,dx = s''\,ds\,\cos\theta$$

But

$$P = P'\sin\theta + P''\cos\theta \qquad (1)$$

Whence

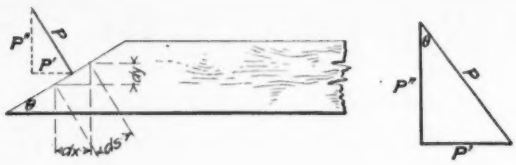
$$P = (s'\sin^2\theta + s''\cos^2\theta)\,ds$$

and the required allowable unit stress is:

$$s = P/ds = s'\sin^2\theta + s''\cos^2\theta \qquad (2)$$

which is "Jacoby's Equation," and is plotted for particular values of s' and s'', and different angles of inclination, θ.

Attention is called to eq. (1). This equation is deduced from a consideration of the equilibrium of forces acting on the small particle of unit thickness, bounded by ds, dx and dy. Admitting for the present that eq. (1) expresses the true relation of these forces, the



point to observe is that this relation must then be that shown graphically by the force diagram at the right.

But from the same force diagram there follows at once:

$$P' = P \sin\theta$$
$$P'' = P \cos\theta$$

which are certainly true if eq. (1) is true.

Then since

$$P' = s'\, ds \sin\theta$$

and

$$P'' = ds\, s'' \cos\theta$$

Therefore

$$s'\, ds = s\, ds$$

and

$$s''\, ds = s\, ds$$

or

$$s' = s'' = s.$$

Or in words, s' and s'' instead of being independent quantities to be substituted in eq. (2) are mutually dependent, being in fact equal to each other and also to (s). This does not deny the truth of Jacoby's equation but merely shows that that equation can have no significance except when $s' = s''$ when it reduces to an identity.

Jacoby started out assuming s' and s'' as two entirely independent quantities, to be determined experimentally; and from his manner of using the equation in practical problems, and particularly from the arrangement of the table in Merriman's "Pocket Book," it is evident that s' and s'' are still meant to be independent. The remarkable fact remains that the derivation is based on the assumption—none the less rigorous for its being unobserved—that the two are equal.

There is a vast distinction between the s' and s'', which are two independent experimental values, and the s' and s'', which are two unit stresses existing together as a result of normal pressure on an inclined surface. It must be apparent that if they are supposed to act simultaneously s' and s'' cannot be independent. It is difficult to imagine how s could be increased without a corresponding increase in both s' and s''.

Further inspection of eq. (1), in which shearing forces are conspicuous for their absence, will disclose the fact that Jacoby's equation is based on the underlying assumption that timber has the characteristic properties of a fluid.

JEROME FEE,
Assistant Engineer, Bay Cities Water Co.
Coyote, Calif.

[The above letter was submitted to Professor Jacoby, who replies as follows:]

Sir: In reply to Mr. Fee, let me say that Prof. Malverd A. Howe advanced similar objections to my formula five years ago. His article and some subsequent discussion by Prof. R. P. Davis (*Engineering News*, Aug. 1, 1912, p. 190, and Sept. 5, 1912, p. 453) should be read in connection with the above letter.

It is doubtful whether a working formula for safe pressures on inclined cuts of wood can be worked out by purely logical methods from a theoretical standpoint. As was pointed out by Prof. Howe and Prof. Davis, the proper way to attack the problem is by experiment. In developing my formula my aim was to produce something that would answer for the practical purposes of design. I believe the formula to answer that purpose very well.

I hope that Mr. Fee may bring forward some other formula, or experimental data on which a formula may be based. Some experiments were reported by Prof. Howe, and a formula based on them, in the reference already cited. With the symbols used by Mr. Fee the formula is

$$s = s'' + (s' - s'')\left(\frac{\theta}{90}\right)^{\frac{5}{2}}$$

Prof. Howe also recommends using the exponent 2 instead of 5/2, as being easier and sufficiently accurate.

Ithaca, N. Y. HENRY S. JACOBY.

[In the just-published book "Timber Framing," by H. D. Dewell, the following comment is made in comparing the Jacoby and Howe formulas: "Mr. Jacoby's curve is the more economical in material, but the results of Mr. Howe's tests are not to be ignored. The data available at present should be supplemented by further tests." Later on in discussing the design of joint details Mr. Dewell says, "It is evident that if the pressures shown by the curve of Fig. 20" which charts Howe's formula "be used, this type of detail must be abandoned, as the required cuts in the chord will be too deep." Thereafter he uses Jacoby's formula exclusively. Evidently further tests are needed.—Editor.]

Variations in Transit Needles

Sir—I have read with much interest the letter from Mr. Newbrough in your issue of Dec. 13, p. 1119, regarding the variation of different needles in the same transit.

The variation of the needles of different instruments has been explained as being the result of mechanical difficulties in the manufacture of the instruments in the locating the zeros of the needle circle in a line in the same vertical plane as the line of collimation. The variations of the different needles in the same transit present indeed a new phase of the subject.

The information indicates that needles of thin section vertically are to be preferred to those having a wider horizontal surface, as it is easy to see with the information at hand that the mechanical axes of the needles in question are evidently not coincident with the magnetic axes, and the thinner the needles are in a horizontal plane the less the likelihood of the magnetic axis being eccentric with the mechanical.

It might be of interest if Mr. Newbrough would test the instrument for local attraction in the instrument itself, by turning the instrument in azimuth in increments of, say, 10° by vernier and circle, and noting if there is a corresponding change in the needle indications.

Columbus, Ohio. SAMUEL P. BAIRD.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Soft Ground Requires Tunnel Instead of Open Cut for Sewer

TUNNELLING was substituted for open cut work for a 10-ft. sewer at Evanston, Ill., on account of difficulties due to soft ground and the danger of breakage of adjacent water mains, although the depth of cover is small for tunnel work.

Roof timbering of the segmental type is built of 3 x 12-in. plank laid flat, each having a 2-in. block nailed

SEGMENTAL TIMBERING USED WITH WEDGE BLOCKS IN SEWER TUNNEL

on each end to give a wider bearing for the wedges. The bottom segments on either side rest upon a short 2 x 12-in. stake driven into the clay to give a firm bearing. This timbering is left in place. When the excavation has progressed well toward the bottom, wood sheet piling along the sides is driven into the soft ground by hand, and braced by a single row of struts. The face of the 8-ft. length of heading being concreted is held by horizontal planks backed by verticals.

Ribs for the steel forms are set as soon as the invert concrete has been placed for the day's advance. Pouring is then started next to the previous section and continued for the 8-ft. length. Concrete is shoveled over the form plates into the walls. For the key it is first thrown into the 4-ft. space above the rear key plate; then the front key plate is placed and the remaining 4-ft. length filled.

Ventilation is provided by the manholes of an abandoned 12-in. sewer near the top of the tunnel. The existence of this sewer has made the ground loose, with a tendency to fall in, especially as there is a small depth of cover over the tunnel. Natural ventilation is sufficient ordinarily, but a fan is used when small gas pockets are encountered.

Two headings are driven from the shaft, which is operated by an engineman and fireman for the hoist and two men to dump the tunnel cars at the headhouse, where they are run on a trestle and dumped into 4-yd. side dump cars on a track alongside the trestle. Each heading crew consists of 3 miners, 2 muckers and a car pusher. Work is done in three shifts, the same men doing either mining or concreting as required. The progress averages 8 ft. per day, but it is expected to increase this to 12 feet.

When tunneling was decided upon, sheet piling had been driven for 400 ft. of open cut, and a tunnel could not be driven inside this, as the roof would not have held. This part of the work was done in two 200-ft. sections, making a top cut with a steam shovel, and then two hand cuts. In the latter, the material was shoveled into cars which ran on an industrial track and were raised by an elevator to a trestle from which they were dumped like those at the tunnel shaft.

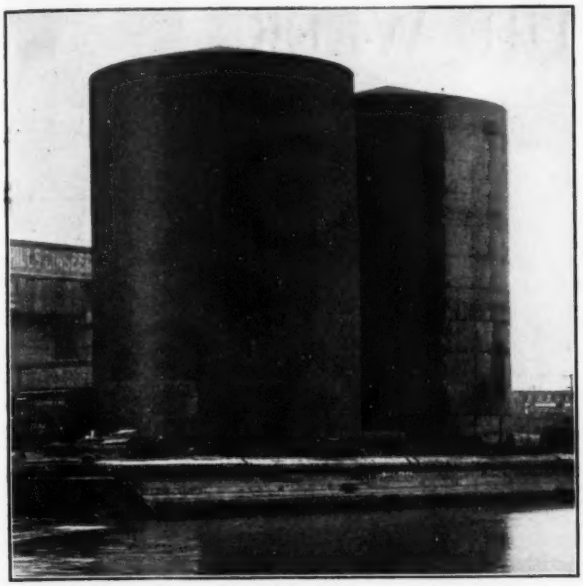
The Nash-Dowdle Co. is carrying out the contract for the Sanitary District of Chicago, of which George M. Wisner is chief engineer, R. H. Burke division engineer, and H. R. Abbott, assistant engineer in direct charge of the work.

High Tanks Loaded on Scow and Moved Across Lake Michigan

BY E. DAUENHAUER
John Eichleay, Jr., Co., Pittsburgh, Penn

A PAIR of steel grain tanks 40 ft. in diameter and 55 ft. high were easily loaded on a steel scow having only 40 ft. beam and moved from Chicago to Milwaukee recently, without mishap. The timber runways used in moving the tanks on and off the barge were blocked in six places to the deck and pivoted on a single support ashore, the deck of the barge riding higher than the edge of the dock and the barge being free to tip in the water under the load.

The tanks were originally 80 ft. in height, but prior to moving them the upper five rings of plates were removed and the tops replaced. Ten jacks were then



SCOW WAS FREE TO TIP AS TANKS MOVED ON

placed under each at equal distances around the circumference and the tanks raised until three 12 x 12-in. timbers parallel to the edge of the dock could be placed under them. Beneath these timbers in turn were placed a pair of 12-in. running timbers, under each end of each stick being set a 4-in. oak shoe bearing on a nest of 8-in. wood rollers. These rollers traveled on two pairs of 12 x 12-in. runway timbers.

The last length of runway was made with four 60-ft. sticks, extending entirely across the deck of the barge and 20 ft. ashore. This last 60 ft. of the runway was laid slightly upgrade, so that when the weight of the tank came on the scow the resulting displacement would bring the scow down about level with the pivot support on shore. This pivot support consisted simply of a 12 x 12-in. block under each pair of runway timbers and perpendicular to the runway at the inshore end of the 60-ft. sticks. The runways were blocked to the deck of the scow at 10-ft. intervals, which made it impossible for the scow to tip so that its deck would no longer be parallel to the plane of the runways.

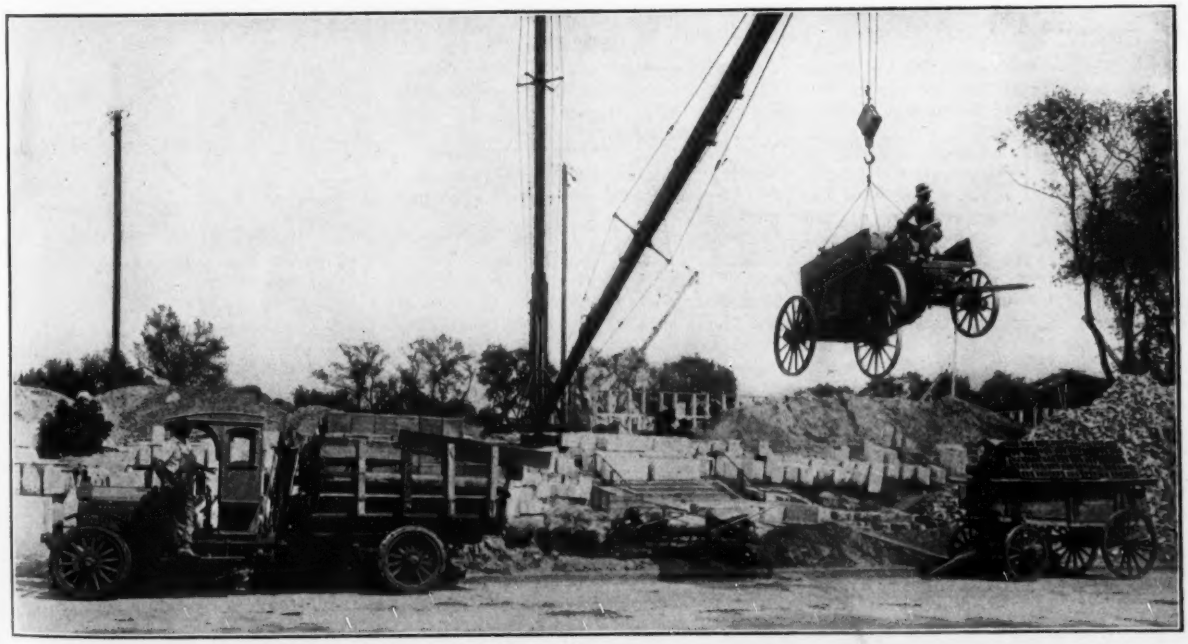
After the tanks were each loaded on the scow, the rollers, the runways and the 12 x 12-in. running timbers above the rollers were removed, and the tanks let down on the three cross-timbers under each. Each tank was then firmly guyed to the scow with ¾-in. steel rods tightened with steamboat ratchets.

The loaded scow was towed down the Chicago River to Lake Michigan. At the first favorable opportunity the trip across the lake to Milwaukee was made in 10 hours. Here the tanks were unloaded and rolled to concrete foundations already prepared for them.

The method of moving the tanks is estimated to have saved a good deal of money over taking them down and re-erecting them. The John Eichleay, Jr., Co., Pittsburgh, executed this work for Armour & Co., Chicago.

Truck Hauls Trailers to Derrick Which Dumps Them

BY LIFTING an ordinary dump wagon over a brick pile the unloading time is minimized on a building job for which Anton Zwack, of Dubuque, Iowa, is the contractor. The wagon is one of two trailers behind a 2-ton Dort truck. On building construction there is usually one commodity that can be handled less carefully than the others from the storage yards to the job. In the photograph the wagon in the air is loaded with ordinary brick while the truck and the second trailer are loaded with tile.



DERRICK DUMPS BRICK WHILE TILE IS UNLOADED MORE GENTLY

NEWS OF THE WEEK

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Details of American Society's Meeting Announced

Details of the 65th annual meeting of the American Society of Civil Engineers, Jan. 16 and 17, have been announced.

The business session will take place as usual Wednesday morning. Because of the abandoning last spring of the annual convention to have been held in St. Paul and Minneapolis, the first order of business at the Wednesday session will be the president's annual address. The proposed revision of the constitution will also come up for action.

Wednesday afternoon a visit will be made to the East River subway tunnel at 60th St. The usual Wednesday evening reception and ball has been abandoned for this year. In its place, however, there will be a theater party at the Hippodrome, followed by a supper and dancing at the Hotel Astor.

Thursday there will be an all-day excursion to Camp Upton, Yaphank, Long Island. In the evening there will be the usual smoker, preceded by a lecture by Douglas W. Johnson, associate professor of physiography at Columbia University, on the topographic features of the French war zone, and their influence on the strategy of the war.

Agricultural Engineers Discuss Lines of Progress

Sewage disposal for farms and small communities, the reclamation of land by irrigation and drainage, and the use of power in farm work, were among the subjects considered at the eleventh annual meeting of the American Society of Agricultural Engineers, held in Chicago Dec. 27-29.

Small septic tanks must be designed on the basis of local conditions of land, water, soil, etc., and no standard design for a tank to serve a certain number of people can be safely recommended. This was the opinion of Robert W. Trullinger, of the U. S. Department of Agriculture. For farms and suburban residences where disposal space is limited the Iowa Engineering Experiment Station has developed a compact combined sewage tank and filter or final purification device in which the outlet forms a contact filter chamber.

The U. S. Public Health Service has had promising results from experiments with a small disposal system consisting of an Imhoff tank and sand bed. Somewhat similar experiments have been made by the state health boards of Illinois and Ohio. This local sewage problem is of increasing importance to the agricultural engineer. Design of such plants by laymen is as dangerous a practice, according to Mr. Trullinger, as home treatment of serious diseases.

A tilting barrel as a substitute for an automatic siphon to discharge the contents of the second compartment of a septic tank of the two-compartment type was suggested by Prof. L. J. Smith, of the Manitoba Agricultural College. This barrel is mounted on pivots in the second compartment, and filled by a pipe from the first compartment. An empty 1-gal. can inside the barrel causes eccentric loading. When the barrel is nearly full this excess weight on one side will tilt the barrel, discharging the contents into the chamber, to which the tile distribution system is connected. For a shallow compartment, as required in flat country with the tile system nearer the surface, a tilting box may be used.

Clearing land of stumps by fires, stump pullers and dynamite was dealt with by L. F. Livingston, University of Wisconsin. The terracing of sloping land, to prevent washing away of the surface soil, was discussed by E. W. Lehman, University of Missouri. Governrment work in rural engineering was reviewed by E. B. McCormick, U. S. Office of Public Roads and Rural Engineering.

Increase of the area of land available for cultivation, in order to increase the food supply and give wider opportunity for settlement of the country, was the theme of a paper on "Engineering Work in Food Supply" by Prof. F. H. Newell, of the University of Illinois. This work includes the supply of water for irrigating arid lands, the removal of excess water from swamp lands by drainage, and the exclusion of water from areas subject to flood overflow. The work of the U. S. Reclamation Service indicates wide possibilities for future successful development on these lines.

The president for 1918 is Daniel Scoates, of the Mississippi Agricultural College. The secretary is R. W. Trullinger, States Relations Service, U. S. Department of Agriculture, Washington, District of Columbia.

Colorado Highway Budget for 1918 Exceeds Last Year's

Approximately $50,000 more will be spent in Colorado on highways in 1918 than in 1917. The new budget of the 62 counties being prepared by the State Highway Commission must meet the total net revenues of $840,000 available. The counties have agreed to raise $750,000, giving the commission a financial working basis of $1,590,000.

Movement To Keep Factories Busy on War Work

Owing to the changed commercial conditions brought about by the war there are a number of factories in this country that are embarrassed by a lack of work. It is extremely desirable that such factories be kept running at capacity; and where they are able to fit in with war activity, that they be utilized for the making of articles needed by the prosecution of the war. Also there are some cases where factories can readapt themselves so as to make articles needed by the Government in the prosecution of the war.

For the purpose of getting in touch with factories where the above conditions prevail, there has been established in the General Engineer Depot of the U. S. Army a bureau for the handling of such cases and correspondence is invited from factories where such conditions prevail.

This bureau is being run by Captain M. Goode Homes, General Engineer Depot, 1438 U St., N.W., Washington.

New York's New Subway May Be Opened in March

Announcement is made by the New York Public Service Commission, First District, that the new Lexington Ave. and Seventh Ave. subways in New York City may be ready for partial operation Mar. 1 and complete operation Apr. 1. It is not certain that these dates will be met. The construction work is virtually completed, but the Interborough Rapid Transit Co. reports delay in obtaining operating equipment.

The Broadway subway from Whitehall St. to Times Square (West 42d St.), the first of the three new trunk subways in Manhattan, is to be opened on Saturday of this week, Jan. 5.

$2,000,000 Contract for Channel Improvement Awarded

Contract for Scioto River channel improvement work at Columbus, Ohio, has been awarded to the W. E. Callahan Construction Co., Omaha, Neb., for a price of $1,993,775. This work as originally designed, following estimates made last spring, was bid on Nov. 15, but the bids exceeded the funds available.

The city therefore reduced the excavation quantity and eliminated some of the concrete revetment. The capacity of the improved channel is reduced by the change, but the work is brought within the available $2,000,000 of funds. Execution of the contract is under direction of Henry Maltzel, city engineer, and R. H. Simpson, engineer of channel improvement.